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SHIPS

OF THE SEVEN SEAS

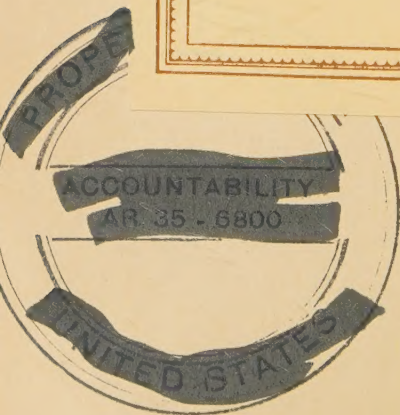


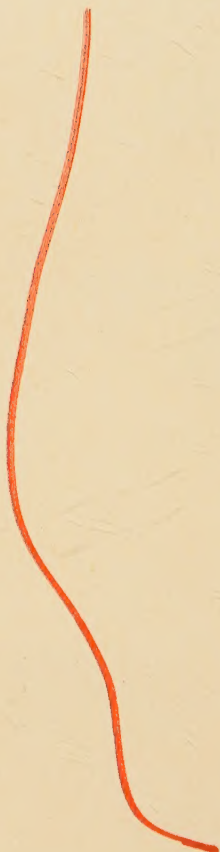
• Hawthorne Daniel •



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SHIPS
OF THE SEVEN
SEAS





*The Santa Maria, the Niña and
the Pinta*

The most famous ships that ever sailed the seas

The Niña, shown in the foreground, was the smallest of the three, but in her Columbus returned to Spain after the Santa Maria was wrecked, and the captain of the Pinta seemed tempted to prove unfaithful.

SHIPS OF THE SEVEN SEAS

by
HAWTHORNE DANIEL

With an Introduction by
FRANKLIN D. ROOSEVELT

Drawings by
FRANCIS J. RIGNEY



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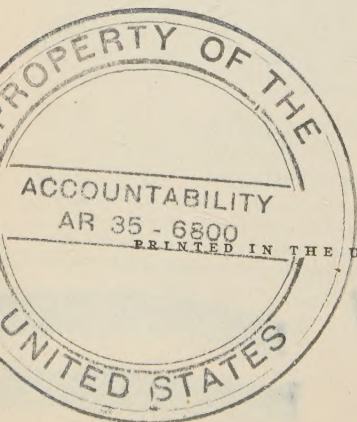
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PRINTED IN THE UNITED STATES OF AMERICA

TO
NELLE R. DANIEL

MY WIFE

WITHOUT WHOSE ENCOURAGEMENT AND
ASSISTANCE THIS BOOK WOULD PROBABLY
HAVE BEEN BEGUN, BUT MOST CERTAINLY
WOULD NEVER HAVE BEEN COMPLETED



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FOREWORD

In gathering material for a book of this kind one's sources of information are likely to be so numerous and so diverse as to defy classification. Some of the information I have gotten first hand on ships in which I have served or voyaged. Much more of it has been picked up from countless scattered sources during twenty years or more in which ships have been my hobby. More still, however, has been consciously taken from books on ships and shipping that I have gathered together or referred to during the time I spent actually in preparing the manuscript.

Those books to which I have most often referred, and to the authors and publishers of which I am particularly indebted, are as follows:

- "Ancient and Modern Ships," by Sir G. C. V. Holmes
- "The Clipper Ship Era," by Arthur H. Clark
- "Dictionary of Sea Terms," by A. Ansted
- "Elements of Navigation," by W. J. Henderson, A. M.
- "The Frigate *Constitution*," by Ira N. Hollis
- "Lightships and Lighthouses," by F. A. Talbot
- "The Lookout Man," by David W. Bone
- "Mercantile Marine," by E. Keble Chatterton
- "Modern Seamanship," by Austin M. Knight
- "Sailing Ships and Their Story," by E. Keble Chatterton

In addition to these I have received much assistance from the New York Public Library, the American Museum of Natural History, the Metropolitan Museum of Art, the

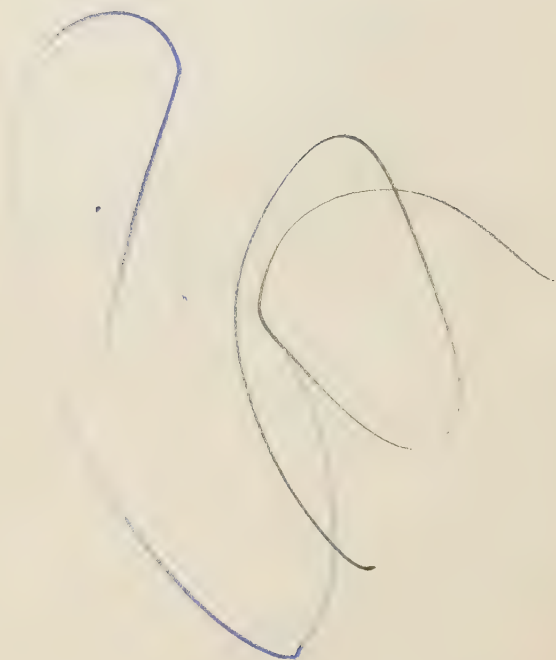
FOREWORD

U. S. Congressional Library, the Marine Museum at the United States Naval Academy at Annapolis, and a number of friends, who, knowing of my interest in ships, have brought me some of the most interesting of the facts that I have used.

H. D.

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INTRODUCTION

I remember well being thrilled as a boy by the tales of various members of my family who had been engaged in the old "China Trade" and in the operation of clipper ships and in whaling. These stories related to a bygone age—a day when the American flag was seen in every part of the globe.

Even in my own boyhood America had no merchant marine except for the coasting trade and the freighters upon the Great Lakes. American seamen had ceased to exist and the calling of an officer in the Merchant Marine was no longer one that offered an attractive career to the American boy. It is unnecessary here to go into the reasons for the decline and fall of our nation upon the sea. The Civil War, the introduction of steam propulsion, the development of the West, and in addition a great number of economic changes, were some of the causes of the disappearance of the American flag from the Seven Seas.

It was not until the outbreak of the World War that American business men as a whole began to think seriously of the possibility of reviving American shipping; it was not until 1916 that the Congress took definite action to aid with constructive legislation; it was not until our own country entered into the war that large results appeared. In the past few years there has been an extraordinary revival of interest in everything that pertains to the sea—the novels of Melville written three quarters of a century ago have been revived in dozens of editions and the sea stories of

Conrad are among the best sellers. In the same way, old books, old engravings, and crude old lithographs and woodcuts relating to almost every form of ships and shipping have been sought out and prized by an ever-growing circle of enthusiasts. This is not a passing fancy; there is something more solid behind it. I hope I am right in believing that the people of the United States are again turning their faces to the sea. Over the sea our ancestors or we ourselves have all come. We have filled the vacant spaces from the original colonies on the Atlantic Coast to the new and splendid civilization of the Pacific. No longer can we say "America is sufficient for us; our thought and lives must stay at home." We are part of the world now, very dependent on the rest of the peoples of the world for our own progress, and our own success, and even for our own safety. This is shown by the fact that every school and every college throughout the land is, in its teaching, paying more and more attention to the affairs of mankind beyond our own borders. The study of languages, the study of geography, the study of economics, of international laws—all receive increased attention.

Mr. Hawthorne Daniel has rendered a conspicuous service in writing a book which can be understood and appreciated by the average citizen. Most of us are just "average citizens" and whether we live a thousand miles from the nearest ocean or not, whether we have ever smelled salt water or not, it will be a good thing for us to have some knowledge of the great epic of ships and the men who have made them and sailed them.

FRANKLIN D. ROOSEVELT.

HYDE PARK, N. Y.,
June 4, 1924.

SHIPS
OF THE SEVEN
SEAS

SHIPS OF THE SEVEN SEAS

CHAPTER I

THE DEVELOPMENT OF SHIPS

IMAGINE the world without ships. Mighty empires that now exist and have existed in the past would never have developed. Every continent—every island—would be a world alone. Europe, Asia, and Africa could have known each other, it is true, in time. North and South America might ultimately have become acquainted by means of the narrow isthmus that joins them. But without ships, Australia and all the islands of all the seas would still remain unknown to others, each supporting peoples whose limited opportunities for development would have prevented advanced civilization. Without ships the world at large would still be a backward, savage place, brightened here and there with tiny civilizations, perhaps, but limited in knowledge, limited in development and in opportunity. Without ships white men could never have found America. Without ships the British Empire could never have existed. Holland, Spain, Rome, Carthage, Greece, Phœnicia—none of them could ever have filled their places in world history without ships. Without ships the Bosphorus would still be impassable and the threat of Xerxes to Western civilization would never have been known. Greater still—far greater—without ships the Christian religion would have been limited to

Palestine or would have worked its way slowly across the deserts and mountains to the South and East, to impress with its teachings the Arabs, the Assyrians, the Hindoos, and the Chinese.

Ships have made the modern world—ships have given the white man world supremacy, and ships, again, have made the English-speaking peoples the colonizers and the merchants whose manufactures are known in every land, whose flags are respected all around the globe, and whose citizens are now the most fortunate of all the people of the earth.

All of this we owe to ships.

Far back before the beginnings of history lived the first sailor. Who he was we do not know. Where he first found himself water-borne we cannot even guess. Probably in a thousand different places at a thousand different times a thousand different savage men found that by sitting astride floating logs they could ride on the surface of the water.

In time they learned to bind together logs or reeds and to make crude rafts on which they could carry themselves and some of their belongings. They learned to propel these rafts by thrusting poles to the bottoms of the lakes or rivers on which they floated. They learned, in time, how to make and how to use paddles, and as prehistoric ages gave way to later ages groping savages learned to construct rafts more easily propelled, on which platforms were built, to keep their belongings up above the wash of the waves that foamed about the logs.

And ultimately some long-forgotten genius hollowed out a log with fire, perhaps, and crude stone tools, and made himself a heavy, unwieldy canoe, which, heavy as it was and awkward, could still be handled much more readily

than could the rafts that had served his forbears for perhaps a hundred centuries.

And with this early step forward in the art of ship-building came a little of the light that heralded the approaching dawn of civilization.

The very first pages of recorded history tell us of ships, and we know that many prehistoric men were adept at



AN EGYPTIAN BOAT OF 6000 B. C.

This drawing was made from what is probably the most ancient known record of a ship. The high bow and stern seem somewhat overdone, and it is likely that they were less elevated than this picture shows them. The carving from which this was taken, however, exaggerates them still more.

building such boats as dugout canoes. In Switzerland many signs have been found of a people who dwelt there in the Stone Age, and among the simple belongings of this people of great antiquity have been found canoes hollowed from single logs. In the bogs of Ireland, and in England and Scotland similar dugouts have been occasionally found, which had been buried in the course of time far below the surface of the ground.

By the time the Stone Age came the dugout was perfected, and still later other types of boats appeared. Perhaps the hollowed log suggested the use of the curved bark of the tree as a canoe, and ultimately a framework of wood was developed to hold the weight of the occupant while a covering of bark kept out the water. The framework was necessary for two reasons—first, to give the structure the necessary strength to keep its shape; and second, to bear the weight of the builder and his belongings. Other coverings, such as skins and woven fabrics covered with pitch, came into use in parts of the world where suitable bark was scarce.

The next step in the building of boats was a method of fastening pieces of wood together in suitable form. This probably came from a desire for boats of larger size, which required greater strength, for man early became a trader and wished to transport goods. Bark could not support a heavy hull, and dugouts are necessarily limited in size, being constructed of the trunks of single trees, although dugouts fifty or sixty feet in length, or even longer, are not unknown. Probably the earliest boats of this new type were tied together by thongs or cords. Even to-day the natives of Madras, in India, build boats by this method, and similar types are to be found on the Strait of Magellan, on Lake Victoria Nyanza in Central Africa, and in the East Indies. Many of these have been very highly developed until now they are built of heavy hand-hewn boards fitted together with ridges on their inner sides, through which holes are bored for the thongs that lash them together. The boards are fastened together first, and later a frame is attached to the interior. This construction makes a very "elastic" boat which bends and twists in a seaway, but which, because of this "elasticity," is able to navigate waters that would prove fatal to the more rigid types of crudely constructed



A LARGE EGYPTIAN SHIP OF THE 18TH DYNASTY

The overhanging bow and stern were common on most early Egyptian ships, and the heavy cable, stretched from one end of the hull to the other and supported on two crutches, was used to strengthen these overhanging ends.

boats. The Hindoos often use them in the heavy surf that drives in upon the beaches from the Bay of Bengal.

The introduction of this construction made boats of considerable size possible, and for the first time boats larger than anything that could possibly be called a canoe were successfully floated.

From this form a further step was ultimately made in which the various parts were fastened together by the use of wooden pegs, and this was the most advanced type long centuries after the dawn of history. The Nile was navigated by such boats at the height of Egypt's civilization, and Homer describes this type of boat as the one in which Ulysses wandered on his long and wearisome journey home.

While the art of boat-building had been travelling this long, slow way, the art of propulsion had not been idle.

Long since, the simple pole of the early savage had lost its usefulness, for men soon learned to navigate waters too deep for poles. The paddle followed, and was perfected to a very high point, as its use in all parts of the world still testifies.

But further means were still to come, and by the time Ulysses started on his journey from the fallen city of Troy, both the sail and the oar, which for three thousand years were to be supreme as propelling forces, had come into use.

In Ulysses's boat, therefore, we see for the first time a combination of structural features and propelling agents that compare, remotely though it may be, with ships as they are to-day. A built-up structure with a framework, propelled by sails—it was an early counterpart of the ships of the present time.

Naturally enough this development did not take place simultaneously in all parts of the world. The most advanced civilizations such as those of Phœnicia, Greece, and China developed the most advanced ship-building methods, just as they developed the most advanced arts and sciences and thought and religion.

For instance, when Columbus discovered America a vital factor in the development of ships was entirely unknown to the natives that he found. No Indian tribe with which he came in contact had learned the use of sails to propel the canoes they almost universally used. Civilizations of surprising worth, with art and architecture in high stages of advancement, had existed and had practically disappeared in Yucatan and Central America, and other civilizations of genuine attainment were later found, by Cortes and Pizarro, in Mexico and Peru, yet only in Peru, and there only slightly, were sails in use at all.

On the other hand, the Egyptians and the Phœnicians used the sail, and twenty-five centuries before the discovery of America the Phœnicians are thought to have sailed their

ships around the continent of Africa from the Red Sea to the Mediterranean.

But while the art of ship-building progressed more rapidly after the development of the use of wooden pegs for fastenings, and the use of sails and oars made possible more extended sea journeys, still the development was slow, and until the discovery of the power of steam in the latter part of the 18th Century no revolutionary changes in ships took place.

Just when the method originated of first constructing the frame of the ship and of covering this frame with planks, we do not know, but the transition from the method in use at the time of Homer was simple and the change was probably gradual.

It seems possible that the built-up boat may have had its



A PERUVIAN BALSA

These "boats" are really rafts made of reeds.

origin in the attempt of some savage to raise the sides of his dugout canoe by the addition of boards in order to keep the water from harming his goods.

But all of the history of boats up to the time of written history is necessarily mostly surmise.

It is interesting to note, however, that every one of these basic types is still to be found in use. In Australia, for instance, are to be found savages whose boats are nothing but floating logs, sharpened at the ends, astride of which the owner sits. Rafts, of course, are common everywhere. Dugout canoes are to be found in many lands, among which are the islands of the Pacific and the western coast of Canada and Alaska. The birch-bark canoe is still common among the Indians of America—particularly of Canada; the skin-covered boat is still used commonly by the Eskimos, two types, the kayak, or decked canoe, and the umiak, or open boat being the most common. I have seen the latter type used also by the Indians who live on Great Bear Lake in northern Canada.

Boats fastened together with thongs or lashings are numerous in parts of India and elsewhere, the Madras surfboats being, perhaps, the best examples.

Boats built up of planks fastened together by pegs are to be found in many parts of the world. I learned to sail in a boat of this type, but very much modernized, on Chesapeake Bay. The other methods, very much perfected, are still in everyday use among boat- and ship-builders.

Thus it will be seen that some knowledge of all these various types may still serve some useful purpose, for one may find in everyday use all the fundamental types of construction that have ever existed.

One type of boat I have not mentioned, yet it is of time-honoured ancestry and is still in daily use among thousands of people. This is the outrigger canoe. In different parts

of the world it has different names. In the Philippines, for instance, it is called, in two of its forms, *vinta* and *prau*. These boats have one thing in common, and that is an outrigger. An outrigger is a pole made of bamboo or some other light wood, floating in the water at a distance of a few feet



AN AFRICAN DUGOUT

In this boat the builders have hollowed out the log but have not otherwise changed it. It is a present-day counterpart of boats known and used long before the dawn of history.

from the boat itself. It is held rigid and parallel to the hull by two or more cross bars. Sometimes there is an outrigger on each side but often there is only one. On the smaller boats the outrigger consists of a single pole. On larger boats, or those which are inclined to be particularly topheavy because of the load they are intended to carry, the size of the sail, or for some other cause, several poles may make up each outrigger. The use of this addition is to secure stability, for

the boats to which they are attached are usually extremely narrow and alone could not remain upright in the water, or at best could not carry sail in a seaway, where the combination of wind and wave would quickly capsize them. These outrigger canoes—and some of them are capable of carrying forty or fifty passengers—are extremely seaworthy, and the native sailors do not hesitate to take them for hundreds of miles across seas often given to heavy storms. In the development of ships, however, they play no part, for their only unique characteristic has never been incorporated into ships of higher design.

It is interesting that while all the cruder types of boats are still to be found in daily use in various parts of the world, the more highly developed designs, up to those of the 17th Century, have disappeared. Many of them, it is true, have influenced later designs, but most of the marks they left can be traced only with great difficulty.

The earliest boats of which we have definite records are those that were in use in Egypt about 3000 B. C. Some of these were of considerable size, for carvings on tombs and temples show them carrying cargoes of cattle and other goods, and show, too, on one side, as many as twenty-one or twenty-two, and in one case twenty-six, oars, besides several used for steering. Many of these boats were fitted with a strange sort of double mast, made, apparently, of two poles fastened together at the top and spread apart at the bottom. These masts could be lowered and laid on high supports when they were not needed to carry sail.

The boats themselves seem to have been straight-sided affairs with both ends highly raised, ending, sometimes, in a point and sometimes being carried up into highly decorated designs that at the bow occasionally curved backward and then forward like a swan's neck. The end of this was often a carved head of some beast or bird or Egyptian god. On



AN ESKIMO UMIAK

This boat is structurally similar to the kayak except that it has no deck. It is a larger boat, and will carry heavy loads and perhaps as many as a dozen people. It is made by covering a frame with skins.

the boats intended for use as war galleys the bow was often armed with a heavy metal ram.

These ships—for they had by this time grown to such size that they are more than canoes or boats—often extended far out over the water both forward and aft, and any concentration of weight on these overhanging extremities had a tendency to strain the hull amidships. This was offset, as it sometimes is to-day on shallow draft river boats, by running cables from bow to stern over crutches set amidships.

While the Egyptians were the first to picture their ships, it is not certain that they were the first to have ships of real size and sea-going ability, for the very temples and tombs on the walls of which are shown the ships that I have described have also the records of naval victories over raiders from other lands who must have made the voyage to the

Egyptian coast in order to plunder the wealth of that old centre of civilization.

The Egyptians, however, were never a sea-going people in the sense that the Phœnicians were. But strange as it may be, the Phœnicians, despite the fact that they probably invented the alphabet, did not make the first record, or, as a matter of fact, any very important records, of their great development in the ship-building art. The earliest picture of which we know of Phœnician ships is on the wall of an Assyrian palace and dates back only to about 700 B. C. which was after the Assyrians had conquered the Phœnicians and had for the first time (for the Assyrians were an inland people) come in contact with sea-going ships.

By this time the Phœnicians had had many years of experience on the sea, and the Assyrian representation shows a ship of more advanced design than the Egyptians had had.

There are few records, however, from which we can gain much knowledge of Phœnician ships, although we know they ventured out of the Mediterranean and were familiar with the coasts of Spain, Portugal, France, and even England, where they went to secure tin. And as I mentioned earlier, they may even have circumnavigated Africa, and it seems likely that they invented the bireme and the trireme, thus solving the question of more power for propulsion.

A bireme is a boat propelled by oars which has the rowers so arranged that the oars overlap and form two banks or rows, one above the other. A trireme is similar except that there are three banks. With this arrangement a boat may have twice or three times as many rowers (in these old boats there was never more than one man to an oar) without lengthening the hull.

To the Greeks we owe the first detailed accounts of the art of ship-building and of ship construction. In early Greek history the vessels were small and were usually without

decks, although some of them had decks that extended for part of their length. They carried crews that ranged up to a hundred or more, and, in the democratic fashion of the early Greeks, they all took part in the rowing of the ship, with the possible exception of the commander. At this early period great seaworthiness had not been developed, and there are many accounts of the loss of ships in storms and of the difficulty of navigating past headlands and along rocky coasts. Later, Greek ships cruised the Mediterranean almost at will, but ship design and construction had first to develop and the development took centuries.

Even in those days there was a marked difference between the ships intended for commerce and those intended for war. The war vessels—and the pirate vessels, which of course were ships of war—were narrow and swift, while the ships of commerce were broad and slow: broad because of the merchant's desire to carry large cargoes, and slow because the great beam and the heavy burdens prevented speed.



AN ESKIMO KAYAK

These small canoes are made of a light frame covered with skins.

During the period at which Athens reached her prime the trireme, or three-banked ship, was the most popular. As a matter of fact, its popularity was so great that its name was often given to all ships of the same general type whether they were designed with two, three, four, five, or even more banks of oars.

These many-oared ships reached a very high state of perfection during the supremacy of Greece, and the most careful calculations were made in order to utilize every available inch by packing the rowers as closely together as was possible without preventing them from properly performing their tasks.

The rowers, as I have suggested, sat in tiers, those on each side usually being all in the same vertical plane, and the benches they used ran from the inner side of the hull to upright timbers which were erected between decks, slanting toward the stern. That is, in a ship with three banks of oars, three seats were attached to each of these slanting timbers and the footrests of the rower occupying the topmost seat were on either side of the man who occupied the second seat in the next group of three. The vertical distance between these seats was two feet. The horizontal distance was one foot. The distance between seats in the same bank was three feet.

I have gone into some detail in describing this arrangement, for rowers—and from the later days of Greece on they were generally slave rowers—were the motive power of ships for three thousand years or more, and for more than a thousand years the many-banked ship was supreme.

Imagine these toiling galley slaves, chained in hundreds to the crowded rowing benches, straining at the heavy oars. Tossed by the seas, they labour unceasingly, stroke on stroke, to the sound of a mallet falling in never-changing cadence on a block of wood. Hour on hour they strain, heartened

occasionally by a few minutes' rest. Their eyes are all but blinded by the sweat from their grimy brows. Their hands are calloused, their bodies misshapen from long toil on the rowers' benches. Above them, on the wind-swept deck, they hear the clank of armed men, the slap of sandalled



A BIRCH-BARK CANOE

In many parts of the world savage people have learned to build light frames over which they have stretched the best material available to them. The Indians of North America commonly utilize birch bark.

feet. A lookout calls to the officer in command—hurried steps—momentary silence—shouts and the sound of feet. A messenger appears in the stifling space below. The sharp clap of the mallet on the block increases its cadence. Faster and faster swing the oars. Furious and more furious is the pace. A whip in the hands of a brutal guard falls here and there on the naked backs of the helpless, straining forms. Their strength is waning, their breath is coming fast. A man

collapses from the strain and pitches from his elevated seat, half suspended by the chain around his leg, his oar trailing and useless. From beyond their wooden walls they hear the muffled clank of the oars of the approaching enemy.

Cries from on deck, and suddenly a crash. Broken oars are driven here and there. Screams and oaths and orders and a great upheaval. Water enters in a score of places. More screams—more oaths—cries for help to a score of pagan gods—the water covers all. A great last sigh and one more ship is gone: it is just a tiny incident in the history of ships.

As I have said, the Greeks developed marine architecture to a very high point, and the bireme and trireme with which they began were the first of a long series of developments until ultimately ships of five, of eight, of even sixteen banks of oars are said to have been in use, and there is a story, which probably was a figment of someone's imagination, of a vessel of forty banks! Such a ship may possibly have been suggested—may conceivably have been built—but it seems certain that she could never have been successful or practical.

Carthage, that great enemy of Rome, was a city of traders—a city that depended on the sea for its wealth and, to a large extent, even for its sustenance. Rome, on the other hand, grew to considerable size without venturing on the sea. When she did first turn her attention to the water, as her continued expansion forced her to do, she found that Carthage crossed her course whichever way she turned. The result was war.

But war between two cities separated by the width of the Mediterranean had to be fought largely on the sea, and Rome, inexperienced as a sea-going nation, was put to a severe test.

By chance, however, a Carthaginian quinquireme—that is, a five-banked ship—battered by storm and abandoned



AN OUTRIGGER CANOE

Sometimes these canoes have an outrigger on each side, and sometimes they carry sails.

by her crew, drifted ashore on the sunny coast of Italy, and the Romans, quick to see the importance of the happening, hauled her high and dry, measured her, and learned from her battered hull the lessons they needed to know of ship construction.

They built on dry land sets of rowers' seats, and while they taught rowers to pull their oars in unison in these unique training benches, they set to work with the energy that marked Rome out for great success. Sixty days after they had felled the trees, they had a fleet of quinquiremes afloat and manned.

Promptly they turned the prows of this new fleet toward the Carthaginians—and were defeated.

But with the indomitable will that characterized the Romans for two thousand years, they went to work again, and built a new fleet and a more powerful one. This time

some inventive Roman devised a kind of hinged gangplank, which could be dropped upon the deck of an enemy ship, maintaining its hold by a heavy metal barb which would penetrate the decks. Across this bridge the Roman soldiers could rush, and by this means could turn a naval battle into what was very nearly the same to these land-trained soldiers as a battle on dry land, where hard blows with sword and spear determined the result.

With this new apparatus the Romans, under Duilius, in 260 B. C., gained a victory at Mylæ, off the coast of Sicily, and after three wars, covering, with intervals between, 118 years, drove the Carthaginians from the sea and razed their beautiful city to the ground.

It is not my purpose, in this chapter, to go into great detail in telling of the development of ships from this time on, for the designs were infinitely great, the variations numerous, and there were, until the 19th Century, but two vital improvements—the compass and a considerable improvement in the ability of sailing ships to make headway against the wind.

Rome, during most of the centuries of her supremacy, controlled every sea within her reach. The Mediterranean was entirely hers, and her galleys and her soldiers ventured into the Atlantic and visited parts of the world that seemed to stay-at-home Romans to be the very fringes of the earth. The ships they built grew in size: the corn-ships, which brought food to the capital from Egypt, are thought to have been as much as 200 feet long, 45 feet broad, and 43 feet deep. When St. Paul was shipwrecked he was in company with 276 others, and the ship they were on carried a cargo besides. These ships carried three masts, each having huge square sails, and on one mast was spread a square top-sail as well.

Roman ships that voyaged to Britain probably gave to the wild men of the North—including those who later be-

came the Vikings—the idea of the sail, and probably all the people of northern Europe learned the use of sails, directly or indirectly, from the Romans.

Ultimately Rome fell beneath the onslaughts of the Barbarians, and the Mediterranean seat of power (although still called the Roman Empire) moved to Byzantium, now called Constantinople.

Here Western civilization resisted for centuries the attacks of the Mohammedans, until the great city on the Bosphorus fell before the armies of Mohammed in 1453.

During all of the centuries that Constantinople had been holding out against the growing power of the Mohammedans, the west and north of Europe were being remade. For a



A PHŒNICIAN BIREME

Despite the fact that the Phœnicians did more with ships than any other ancient peoples before the Greeks and Romans, little is known of Phœnician ships. They developed the bireme, an oar- and sail-driven ship with two "banks" of oars, and circumnavigated Africa.

time Western civilization seemed doomed, for the Moorish Empire in North Africa had pushed across the Strait of Gibraltar, had subjugated Spain, and had crossed the Pyrenees into France, where, fortunately, their great army was put to rout at the battle of Tours in 732. But although they were driven from France they maintained their hold upon Spain, and not until the Granada Moors were defeated by Ferdinand and Isabella in 1492 was Spain again free of them. They controlled North Africa from Suez to Gibraltar and introduced many Eastern ideas. It is probable that the lateen sail, which originated in Egypt and is still in common use in the Mediterranean, owes at least some credit to the Moors for its introduction to western Europe.

In addition to the influx of Mohammedans, civilized Europe had to contend with the hordes of barbarians that descended from the wild country to the north of the Alps, for the most of Europe except its Mediterranean fringe was a dark and barbarous land. But the centuries that we call the Middle Ages saw a growth of culture, a growth of learning, a growth of nationalism that were to make the modern world. In all of this ships played a vital part.

The Vikings, with their open boats, propelled by oars and sometimes aided by great square sails, terrorized Britain and northern Europe for a time, even driving their boats up the Seine to the walls of the city of Paris, which was then built on a tiny island in the river. But at last the Saxons, under Alfred the Great, with the first ships of the long series of ships that were built to protect England, drove the wild sailor warriors away, and a new epoch had begun.

During this time Venice and Genoa had developed, and the ships that sailed from those two cities were for a time the proudest of the world.

But their development was so largely commercial that it was only with difficulty that they could maintain navies

capable of protecting their vast fleets, which were attacked by pirates, by the ships of other cities, and by each other so constantly that sea-going was a hazardous occupation, and ships perforce sailed always in convoys, or at least in the company of other ships, for protection. Then in the north



A GREEK TRIREME

These warships were about 120 feet in length, and the sails and spars were taken down and sent ashore if battle was expected. The oars were operated by slaves.

William the Conqueror crossed the English Channel, defeated the Saxons at the Battle of Hastings in 1066, and the foundations for the present British Empire were laid. If the Saxons had developed a navy with which they could have met and defeated the Norman conqueror on the sea, think of the enormous difference it would have made in the history of Britain.

During the Middle Ages following the conquest of Britain, an association of northern European cities, called the Hanseatic League, was formed in order to protect their trade, and for a time proved to be a very important factor in the maritime development of the north of Europe. Had Venice and Genoa formed such a coöperative association instead of frittering away their strength, bickering and fighting, another story would have been written in the Mediterranean.

During all this time ships had been changing gradually in design. Oars still drove the fastest ships of war in the Mediterranean, but sails had taken a more important place, and now whole voyages were made by means of sails alone.

The 15th Century came, and with it the fall of Constantinople; and with it, too, in Genoa, that nautical city of Italy, the birth of a child named Christopher Columbus. He grew to manhood and became a sailor, and sailed on voyages here and there, and was wrecked finally on the coast of Portugal. But here was no ordinary man. Thousands of other sailors had had his opportunities, but none of them took so seriously the idea that the world was round. The idea, of course, was not Columbus's own. It had received some attention for centuries among a few great minds. But Columbus, not content with accepting the shape of the world as a theory, wanted to make the voyage that would prove it. Already, in the previous century, a great stride had been made in seamanship by the introduction of the compass. This appeared mysteriously in Mediterranean waters, from no definitely known direction, but it seems probable that it came, by a very indirect route, from China, where it had been known and used for many years. Probably this introduction of the compass to the Western world was made by the Mohammedans, for they traded as far east as the Persian Gulf—perhaps farther—and natives of

India, with whom the Chinese came into occasional contact, often made the voyage from India to Muscat, so that it seems likely that the compass came to Europe by this route.

But to return to Columbus. He took his idea to the King of Portugal, and was turned away. From Portugal the penniless sailor turned to Spain, and many times was refused by the monarchs of that country, for they were busy at the time with the final expulsion of the Moors. After several years of unsuccessful petitioning at the Spanish Court, Columbus gave up and started on his weary way to France. But Queen Isabella sent a messenger after him, and he was recalled and told that he could make the attempt to discover the westward route to India with the aid and under the flag of Spain.

On August 3, 1492, he sailed from Palos in command of three little ships—three ships that are now more famous than any others that ever sailed the seas; and with these ships—the *Santa Maria*, the *Niña*, and the *Pinta*—he discovered a new world and opened new seas that now are crossed and recrossed constantly by such a fleet of ships as Columbus could never have imagined.

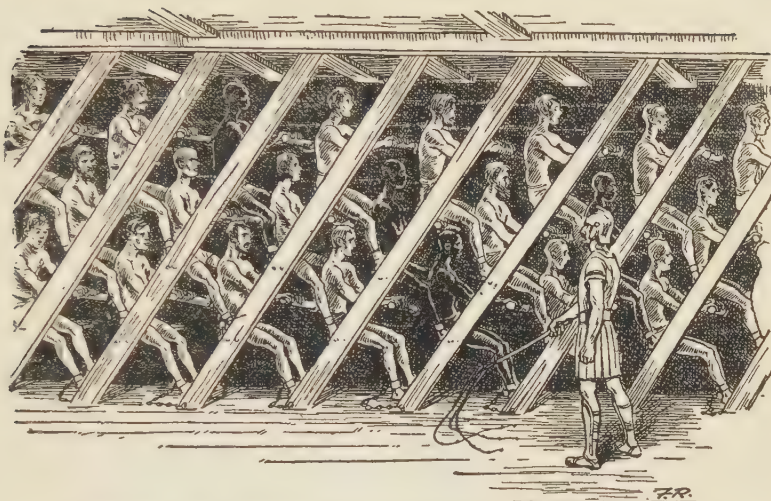
By the end of the 15th Century, as I have suggested, ships had gone through a series of developments that had made them more seaworthy and more reliable, but still, from the viewpoint of to-day, they were crude and inefficient craft in which the modern sailor would hesitate to venture on the smoothest of summer seas. The ships of war, so far as the Mediterranean was concerned, still favoured the oar, and still used sails as auxiliary power, although England and France, and the other newer nations of the north of Europe, were developing sturdy ships that depended almost solely upon sails, although they often carried great overgrown oars called sweeps, with which the ships could be moved slowly in the absence of the wind.

The galleys of the Mediterranean were no longer the many-banked ships of Greece and Rome, but were, instead, low, narrow vessels with huge oars from thirty to fifty feet long, to each of which several men were assigned, thus securing the man power that the many-banked ships had utilized with more numerous oars. In order to manage these ungainly oars a framework was built out from each side of the ship, and attached to this framework were the oarlocks. This arrangement has its present-day counterpart in racing shells which, being barely wide enough for the rowers, cannot balance its oars in locks attached directly to its sides. Therefore a framework of steel rods is built opposite each seat in order that the oarlock may be at such a distance from the rower that he may get the necessary leverage to make each stroke effective.

The Crusades, which began in the 12th Century, had acquainted western Europe with many luxuries of the East hitherto unknown to the rougher people of the West, and as a result, trade increased greatly, necessitating the building of many ships, and as is always the case, progress was made because new minds were put to work. In this case ships improved. Metal nails, expensive as they were, for they were made, of course, by hand, had come into use, and new designs took the place of old.

The ship that, at the time of Columbus, was the most popular was the caravel. To our eyes she was ungainly, crude, and unseaworthy, yet these clumsy vessels, with their high sterns and overhanging bows, made most of the early voyages of discovery—voyages that for romance, for adventure, for danger, and for importance, rank higher than any others that were ever made.

Two of Columbus's three ships were caravels. The *Nina*, however, was but a tiny cockleshell, only partially decked, that proved, by chance, the most valuable of the three, for



SEATING ARRANGEMENT OF ROWERS IN A GREEK TRIREME

While there were other arrangements that were sometimes used, this seems to have been much the most common. The slaves who operated the oars were chained in place, and in case of shipwreck or disaster were usually left to their fate.

in her Columbus was forced by circumstances to return to Spain after the *Santa Maria* had been wrecked by a careless helmsman on a far-off island in the world that she had found, and the *Pinta* had wandered away, the Discoverer knew not where, in the hands of men tempted to be unfaithful to their great commander.

So important was the work done by the *Santa Maria* and the other caravels of her day that were sailed by Vasco da Gama around the Cape of Good Hope, by Americus Vesputius to the South American mainland, by the Cabots to Nova Scotia and New England, and by other great discoverers on other great voyages, that they warrant closer attention than has been given to other passing types. With a fleet of caravels Magellan sailed from Spain, crossed the Atlantic, skirted the South American coast, discovered the land we

now call Argentina, where he found a people he named the "Patagonians" because they had big feet. In subsequent accounts by a member of his crew these people were said to be giants, although they are merely men of good height and strength. From Patagonia, Magellan sailed south and entered a channel on each side of which lay mighty mountains rising precipitately from the water. The land to the south he named Tierra del Fuego—the Land of Fire—either because of the glow of now extinct volcanic fires that he saw, or of distant camp-fires of the natives which he sighted as he made the passage, and this land for many years was supposed to be a great continent that stretched from the Strait of Magellan, as the passage Magellan found was later called, to the south polar regions.

From the western end of the Strait, Magellan steered to the north and west, diagonally across the greatest expanse of water on the globe—an ocean discovered only a few years earlier by Balboa when he crossed the Isthmus of Panama, and named by him the Great South Sea, but renamed by Magellan, because of the gentle weather he encountered, the Pacific. In all the voyage across the Pacific he discovered but two islands, although he sailed through the section occupied by the numerous archipelagoes that we call the South Sea Islands.

After terrible suffering from scurvy, from lack of water, almost from starvation, the little fleet of four ships (one had deserted just after the Pacific was reached) finally reached the Philippines. Already Magellan had sailed under the Portuguese flag around the Cape of Good Hope to a point in the East Indies farther east than the Philippines, so he was, actually, the first man ever to circumnavigate the globe. In the Philippines, however, he was inveigled into an alliance with a perfidious chief named Cebu, who, after witnessing Magellan's death at the hands of the natives of a neighbour-

ing island (he was pierced in the back by a spear), captured and murdered two of Magellan's chief officers, after which the dwindling band of adventurers burned one of their ships, for they were short-handed, and sailed to the south and west with the remaining three. Two more ships were lost ere the Atlantic was again reached, and at last the *Vittoria*, the only ship remaining of the original five, reached the Canaries, where thirteen men out of the forty-four who still remained were thrown into prison by the Portuguese governor, and only thirty-one of the original two hundred and



AN EARLY 16TH-CENTURY SHIP

This ship, while similar in many respects to Columbus's Santa Maria, has made some advances over that famous vessel. The foremast is fitted to carry a topsail in addition to the large foresail shown set in this picture. On ships somewhat later than this one a small spar was sometimes erected perpendicularly at the end of the bowsprit, and a sprit topsail was set above the spritsail which is shown below the bowsprit here.

eighty returned to Spain to tell their wondering countrymen the story of their travels. That voyage, saving only the first voyage made by Columbus, was the greatest in the history of men upon the sea.

These voyages, as I have said, were mostly made in caravels. None of the ships was large, and Columbus's flagship, the *Santa Maria*, was below rather than above the average. Vasco da Gama's ships were larger, as were many others. But no other ship in history is so widely known as that little vessel of Columbus's, and a description of her, being a description of caravels in general, is of double interest.

From bow to stern she measured but ninety feet, and she displaced about one hundred tons. But more than that is needed to give one an adequate idea of her limitations. The bow was high and awkwardly overhung the water by twelve feet, not being carried gradually out as are the bows of sailing ships to-day, but jutting ponderously forward from an almost vertical stem. Amidships the deck was low, dropping down abruptly about one fourth of the way aft. This midship deck (it was called the waist) was unbroken for another fourth of the vessel's length, and then another deck was built at about the level of the forward deck, behind which a high sterncastle reared itself aloft until it surpassed the altitude of the forward deck, but fortunately did not jut out over the water aft as the bow did forward.

These two raised sections at the opposite ends of the ship were originally built with the idea of defense in mind. Ships for many centuries had had raised platforms fore and aft, on which the men who defended them could congregate in order to rain their arrows upon the decks of enemy ships. So useful were these "castles" that often enemy boarders were able to penetrate to the waist only to be driven off by the rain of missiles on their heads. When gunpowder came into general use tiny cannon were mounted in swivels

attached to the bulwarks of these "castles," but old ideas were not easily got rid of, and for a long time ships continued to be built with raised bows and sterns.

So it was that the *Santa Maria* had her forecastle and her sterncastle. The former term is still in use on ships, and signifies the quarters of the crew, which still are often placed in the bows of ships. The sterncastle has no present-day counterpart, and the name, too, has long since disappeared from ships.

The cabin of the great Admiral was aft, in the topmost section of the sterncastle and was, from our point of view, not exactly palatial. It had a bed, which looked more like a chest except that it had highly raised head and foot boards of carved wood. There was a table, and there was little else. A door opened on to the high narrow deck, and windows (ports such as ships now use were not then thought of) opened in the narrow stern high above the water.

The crews' quarters were almost non-existent. Generally they slept on deck, although there was room between decks for some of them. This space, however, was not ventilated (that, of course, had little effect on a 15th-Century Spaniard. Even the Spaniards of the lower classes to-day seem somewhat averse to ventilation) and was devoted to cargo and supplies. Below this space was the "bilge" which was filled with stone for ballast. The raised forward deck was in reality just a platform that incidentally formed a roof over the forward section of the main deck—the deck, that is, that formed the waist—and beneath this forecastle deck were protected spots where the crew could secure some shelter from the weather. They cooked, when they cooked at all, on a box of small stones that sat on the main deck just under the edge of the raised forecastle. This crude fireplace was decorated by a large square plate of zinc that stood upright, attached to one side of the box, to serve as a windbreak.

Below, swishing around among the stone that formed the ballast, was the ever-present bilge water that was always a serious problem in these ill-built hulls. It was a never-ending annoyance, even in fair weather, and had constantly to be pumped out or bailed out. And when these ungainly craft met with heavy weather their situation was serious, for the strains caused by the waves opened seams here and there, and often allowed so much water to enter that foundering resulted. Even when Spain, ninety years after Columbus, sent her vast Armada to threaten England, only to have it defeated by Drake and his companions, and scattered by the North Atlantic storms after it had rounded Scotland in its attempt to return to Spain, ship after ship, tossed by the boisterous seas, twisted and groaned and opened her seams, and sank in the cold black water or drove head on to the rocky coast of Ireland. The great storm they encountered sank twenty times as many ships as did the fleet that so ably defended England.

And in such ships as these the hardy men of bygone times searched out the unknown lands of earth, braved the storms of great uncharted seas, braved, too, the unknown dangers which, exaggerated by their imaginations, grew to such size as might have made the bravest quail. And when their ships were dashed to wreckage on some uncharted rock, or filled with water when their seams were spread, those who saved their lives and managed to return to port, shipped again and faced the same threatening dangers.

In the adventurous days that followed Columbus, ship design and ship construction developed rapidly. The desire to carry heavy guns led to placing them on the main deck where they fired over the low bulwarks or wales which since then have been called gunwales. Then the desire to carry more guns led to placing them between decks where ports were cut in the sides of the ship for them to fire through.

The British and the French led in both design and construction, the British having built ships of 1,000 tons as early as the reign of Henry V in 1413. But so far as size was concerned, other nations followed suit, and when Medina Sedonia came driving up the English Channel with the 132



A MEDITERRANEAN GALLEY

This ship is of the type used long after the Middle Ages. Several men pulled each oar and all the oars were in one bank.

ships of the Spanish Armada stretched in its vast crescent, at least one ship was of 1,300 tons.

But the oaken fleet of England, while it had no ship quite to equal in size this giant Spaniard, was more than a match for the Don, and Drake, that master of seamanship, refused to drive alongside the clumsy Spaniards, but lay off,

instead, and peppered them with gun-fire, and following them up the English Channel, fell upon those that dropped behind.

The opening of the Americas and the East to trade and colonization resulted in an expansion of ship-building such as the world had never before known, an opportunity of which an oar-driven ship could never have taken advantage.

Portugal, for a time—owing to her many colonial possessions, which now have largely faded away—became a great sea power, which, however, shortly suffered eclipse. Spain, despite the terrible catastrophe that befell her great Armada, remained a power of real strength for a century longer. The Dutch, those hardy sailors from the low countries, for many a year sailed to and from their East Indian possessions, proudly conscious of the fact that they were supreme upon the seas. And the French, although their strength at sea was never clearly supreme, nevertheless built navies and sailed ships second to none, or at the least, to none but Britain.

But one by one these sovereigns of the seas gave up the place to another, and the 18th Century saw a new ruler of the waves, when Great Britain at last bested Napoleonic France at the Nile, at Aboukir, and at Trafalgar.

By this time ships had grown greatly in size, and by the opening of the 19th Century the great three-decked line-of-battle ships were more than 200 feet in length, were 55 feet broad, and displaced 3,000 tons or more. Such a ship could not be termed small even in the light of ships of a century later.

But the opening years of the 19th Century brought forward an invention which, laughed at and disdained by "wind-jammers" for half a century, proved, at last, despite their jeers, the force that swept from the sea all but a handful of the proud vessels that for nearly five thousand years had

spread their sails to the winds of Heaven and had gone to the uttermost parts of the earth.

A hundred years after the *Charlotte Dundas* had churned the waters of the Forth and Clyde Canal and the *Clermont* had splashed with her paddle-wheels the waters of the Hudson, sailing ships had become rare, romantic links to connect the modern world with that adventurous period that lay before the era of invention and machinery.

With slow steps the 19th Century ushered in the recognition of the power of steam—a new departure in the history of the world. But ere five score years had passed, the wheels of factories whirled in deafening array, electric motors whined with endless energy, and huge propellers, spiralling through the deep green sea, drove great ocean-going palaces from continent to continent, careless of winter's winds or summer's sultry calms, all but thoughtless of the powers of nature which, since the dawn of history, had been the ruling thought of all of those who have ventured on the surface of the deep.

CHAPTER II

THE DEVELOPMENT OF SAILS

THE origin of sails is buried in the darkness of prehistoric days. Perhaps some hunter, paddling his dugout canoe before the breeze, had his loose skin cape distended by the wind which continued to propel him even when he stopped paddling in order to fasten his garment more closely about him. No doubt something of this kind occurred many times before some prehistoric observer noticed the cause and related to it the effect. Perhaps, then, he held the skin up on his paddle or on his staff, and sat back in comparative comfort while the breeze did his work for him. Certainly such an origin is possible, and man's desire to accomplish certain ends without expending his energy unnecessarily may, in this as in many other things, have led him to take so important a step toward civilization. From using a skin held on his staff to spreading the skin on a stick which in turn was held up by another stick was but a step, and an excellent means of propelling his canoe had been developed. The perfection of this method of propulsion, however, was slow. How many years before the dawn of written history such sails were in common use we do not know, nor can we guess with any accuracy. It is probable, however, that the time was long, for the very first accounts we have of ships tell us, too, of sails.

I have already traced the development of ships from this early time, and it is not my desire to retrace my steps more than is necessary, for ships have always progressed as their propulsion progressed, and consequently the story of ships is

also the story of propulsion. But sails, it would almost seem, had less to do with the early development of ships than oars, which for many thousand years after the dawn of history were apparently more important in the eyes of men of the sea than sails.

Because of this attitude toward oars, and perhaps, too, because of the comparatively restricted waters in which ships originated, the inventive genius of early designers seems to have been expended almost wholly upon the perfection of the use of oars, until, as I have explained, truly great ships were built in which much thought was given to the proper seating of hundreds of oarsmen.

Sails, then, progressed little, save in size, beyond the skin that first was stretched before the breeze in some remote savage genius's canoe, and, until the Crusades began at the



AN EGYPTIAN BOAT OF THE 5TH DYNASTY

The double mast, shown in this drawing, was in common use in Egypt about 3000 B. C. It is occasionally to be seen on native boats in the Orient to-day.

end of the 11th Century, sails and spars remained simple and, from the viewpoint of to-day, comparatively inefficient. With a favouring wind ships could hoist their sails and proceed merrily enough, but with a wind even mildly unfavourable sailors sometimes lay in sheltered harbours for weeks or got out their oars and proceeded on their way with strenuous labour.

When ships first began to utilize sails to go in directions other than approximately that in which the wind blew is unknown. Certainly ships propelled by even the crudest sails could do more than drift before the wind, and as hulls became longer and deeper, they were, of course, able to sail more and more to the right and left. When, however, ships first were able to make headway against the wind is problematical. Certain it is that for many thousand years after sails were known there seems to have been no connection in the minds of ship-builders between the use of sails and the construction of the underbodies of their ships so as to interpose any especial obstacle to the water in order to prevent the undue motion of their hulls *sideways*. Naturally enough, the very earliest of ships was constructed with the idea of ease of propulsion forward, but, so long as that object was gained, the shape of the hull, apparently, gave them little thought save in so far as space was needed for crew and cargo. Designs were brought out, of course, that were increasingly sturdy and seaworthy, but fin keels, or similar contrivances, are a development of recent times.

Ships there were, of course, even in ancient times, that were driven exclusively, or almost exclusively, by sails, but the fact that these ships, and many that depended largely on oars, were hauled high and dry and carefully laid up during the less favourable seasons would seem to prove that except under ideal conditions sails, as they were then, were highly impractical affairs.

The earliest sails of which there is definite record are those shown in carvings of ships on ancient Egyptian temples. These were hardly more complicated than the skins of the theoretical savage who first utilized the energy of the wind. They were made of cloth and were rectangular and were



AN EGYPTIAN SHIP OF THE 12TH DYNASTY

It is possible that ships of this type were able, under ideal conditions, to make a little headway, while under sail, against the wind. It was not for many, many centuries, however, that sailing ships were able definitely to make much headway in that direction.

stretched between two spars—one at the top and one at the bottom—and these spars were raised and lowered in the process of making or taking in sail.

Now this method of stretching a sail is not inefficient. The cloth can be held more or less flat, and such a sail could, if the hull of the ship were so constructed as almost to prevent lateral motion, propel the hull in the direction it was pointed,

even though that direction were at right angles to the wind. If the hull were properly designed, such a sail might readily be made to propel the hull at a little less than at right angles, and, once that were done, the ship would actually be making headway against the wind. It is quite conceivable that the Egyptians had perfected this art—not, perhaps, with the sail I have mentioned, but with a later development of this sail when the lower spar had disappeared and the upper spar had become greatly elongated and was set at an angle to the mast, so that from it depended a great triangular sail, called, now, a lateen sail.

But authorities differ, and although there has been much argument as to whether Roman ships of a much later date—for instance, the one in which St. Paul was shipwrecked—could sail so as to make good a course even slightly against the wind, the argument has still remained only an argument, with neither side definitely able to make its case. And this, it seems to me, proves that while perhaps under ideal conditions and with some ships this highly important end was sometimes gained, nevertheless, the ancients were not, by and large, able to sail any course save when the wind was blowing from some angle of the half circle toward the centre of which the ship's stern was pointed, or, in the language of the sea, when the wind was "abeam" or "abaft the beam."

But while sails were not perfected, and consequently were of particular use only when the wind was more or less astern, ships grew in size, and consequently more sail area was required to propel them. This resulted in the enlarging of the single sail until it grew clumsy and finally resulted in the use of more than one sail, each spread from a mast of its own. Later still, in these ships carrying several masts, one would sometimes carry two sails, one above the other. Occasionally, ships with but one mast similarly subdivided their great square sails. Roman ships of the larger sizes



A ROMAN SHIP

Although this ship was small the Romans built many that were not surpassed for 1,700 years, and it was not until the 19th Century was well advanced that the larger Roman ships were greatly surpassed in size.

—notably the corn-ships that brought food to the capital from Egypt—developed this subdivision of sails, but it was hardly more than a subdivision for more than a thousand years after the time of Christ—in reality, not for 1,500 years, for even the caravels of the time of Columbus had few actual improvements over the earliest ships of the Christian Era. It is true that the lateen sail had been adopted largely for use on the mizzenmast—or third mast from the bow—and that that sail has more driving power than a square sail when the ship is heading into the wind. But still ships were weak in “going to windward”—that is, in making any headway in sailing into that half of the compass’s circle that is marked by ninety degrees to the right and to the left of the point directly toward the wind. This is borne out by the complaints of Columbus’s men, who, when they found

themselves being driven westward day after day with the steady Trade Winds from behind them, expressed their fear of never again being able to return to Spain.

But, clumsy as these old sailing ships were, they came and went, searching farther and farther into the unknown world, proving, beyond doubt, that men have always been able to get along, even with crude instruments, and that, in the last analysis, men are more important than equipment.

So awkward in our eyes were the ships of Columbus's time that when replicas of his original ships were built in 1893, for the World's Fair at Chicago, and were sailed by Capt. D. U. Concas, an experienced modern seaman, over the course Columbus took, the feat was looked upon as extraordinary, despite the fact that Captain Concas's knowledge of winds, currents, and navigation was infinitely superior to the great discoverer's. So great were the steps taken in 400 years of ship-building that this feat, far simpler than scores that are recorded in the stories of the old adventurers, was hailed as heroic. But we have accustomed ourselves to sailing ships that can be handled with such marvellous ease that it would take an exceptionally able and fearless sailor to handle even that replica of the *Santa Maria* that still is to be seen anchored in a park lake at Chicago. He would be a truly fearless or a truly foolish man who would attempt to take her across Lake Michigan in anything more than the mildest of summer zephyrs.

But once the voyage of Columbus had taught Europe how little it really knew of the world there came the insistent demand for better ships, and as ships had by this time reached the point where far the greater part were propelled by sails alone, the demand for the perfection of ships resulted in the perfection of sails as well as the perfection of hulls. England and Holland, together with the other northern European countries, are largely responsible for this improve-

ment, although France for many years built the finest ships that sailed the seas.

Down to the 14th Century the ships of northern Europe showed strongly the Scandinavian influence. The Vikings had developed ships similar in shape to the whaleboats of to-day. They were double-ended affairs, long, low, narrow, and fast, propelled largely by oars, but carrying, generally, one large square sail set about amidships on a sturdy mast.

In these ships the Norsemen regularly sailed the Baltic and the North seas, where the elements give even the ships of to-day many a vicious shaking. Yet these sturdy old pirates, for they were hardly more, ploughed their way through storm and fog, without compasses, without any



A VIKING SHIP

These ships were developed by the Norse sea rovers for use in war, and as the seas they sailed were generally rough their ships had to be seaworthy. The result was a type that still leaves its mark. The seaworthy whaleboats of to-day are very similar in shape.

method of determining their positions at sea except their instinct and what guesses they could make—measuring voyages not by miles but by days—coming, going, bent only on conquest and on pillage. Nor did they confine themselves to the more or less landlocked seas. They launched their sturdy boats from the narrow beaches of Norwegian fjords, and with sturdy backs bent to sturdy oars, and great, colourful square sails set when the wind was right, drove their ships to Scotland, to the Orkneys, the Faroes, and to Iceland, and not content with that drove on to Greenland, to Labrador, to Nova Scotia, and probably drew up their ships on the shores of the very bay that waited yet another half a thousand years ere the Pilgrims saw it from the unsteady deck of the *Mayflower*.

In their open boats that tossed like flotsam among the angry waves, these hardy mariners lived. Their food must often have been hardly edible, their supplies of water hardly fit to drink, and comfort there never could have been. Wet through by boarding seas, all but unprotected from the cold of long sub-Arctic nights, or scorched by the sun in breathless summer calms, their beards caked with salt from the driving spray, or dripping moisture left there by the fogs, these heroes of the sea swung their oars for days, for weeks, perhaps for months, and feared the great Atlantic not at all.

They built these ships of theirs from the lumber that covered Norway's mountain-sides. They hewed the timbers, and fashioned them, and made their ships as artists paint their canvases, not by the aid of mathematics but by the aid of the innate art that was theirs and the experience of generations of forefathers bred to the sea. They launched their ships into the slate-gray waters of the stormy north, and stocked them with rough food and rough implements. They shoved off from the rocky coast of the land that had bred them and swung their great oars over the crests of the surging

sea, and clear of the land hoisted their sails and were gone to new worlds far across the ocean.

To us who live in a world so supercivilized that the Norseman's wildest dreams could not have approached the commonplaces of modern life, it is difficult to imagine a crew of



A 13TH-CENTURY ENGLISH SHIP

The Viking influence is still easily traceable in this ship, but the forecastle and the sterncastle have put in their appearance. Also the hull is heavier than and not so sharp as in the earlier Viking ships.

these stern and brawny men, fifty or sixty strong, perhaps, with their barbaric helmets temporarily laid aside, with their shields hung along the gunwales, and with their great backs bending in unison to the oars. Seated on the heavy thwarts, their supplies below their feet, their swords and battle-axes strewn about carelessly, but handy to each cal-

loused palm, they pulled for hours, chanting their songs of war, roaring their choruses. Pausing now and then to rest or to fill horn flagons from some supply of ale; tearing with their teeth at salted fish or haunch of tough dried meat; changing their positions now and then, perhaps, to keep their hardened muscles from growing stiff; sleeping in the bow or stern, or down among the bales and bundles that lined the long, low hull; wrapped in homespun capes in rain or fog or driving spray—thus did these hardy mariners sail to the west and home again. Leaving a land where life was hard, they journeyed far to other lands at least as bleak as theirs, and journeyed back again, not looking for the land of spice, or summer seas, or far, romantic Cathay. Of such climes they knew nothing, nor did they care.

As time passed these ships became heavier and broader, with more draft and with higher sides, although they still retained the sharp stern which was somewhat similar to the bow. The sails, however, developed little and about the only complication was an additional strip of canvas that could be laced to the foot of the sail, increasing its area considerably. In light winds this was attached. In heavy winds it was unlaced. This, by the way, was a common feature before the later methods of reefing sails came into use.

But now we come to a time when ship designers began consciously to refine the crude ships with which they were familiar. As a result, sails from 1450 to 1850 went through a process of development far exceeding the development that had taken place during those unnumbered centuries from the time of the first sail up to 1450.

So complicated is the story of this development and so limited is the space in a single book that I must content myself with utilizing only the remainder of this chapter for the story of the development of sails during the first 350 of these 400 memorable years, leaving for the following



A GALLEON OF THE TIME OF ELIZABETH

The extremely high stern and the low bow shown in this drawing are about as extreme as any in use during the period when high bows and low sterns were thought to be good design.

chapter the story of the final perfection of sailing ships which took place in the first half of the 19th Century.

It is not difficult to see what happened to make the development of sails so slow a process. Not only sails, but also practically every art and interest of mankind had received a serious setback with the decay of Rome. The Dark Ages followed with their woeful ignorance, and it was not until after the Crusades had been followed by the Renaissance, which brought with it a renewed interest in every subject the people of Europe knew anything about, that ships—and practically everything else—began to recover from the fearful retrogression that had taken place during the better part of ten centuries.

It was not, for instance, until the latter part of the 15th Century that the bowsprit appeared in common use in northern Europe, although this feature had, fifteen hundred or more years before, been in common use on Roman ships, where it was used to carry a small square sail called the "artemon." The bowsprit seems to have originated as a sort of mast that was set far forward in the bow, in order that a sail spread from it would be in the best position to aid in swinging a ship from one side to the other. In order to make this sail still more effective by giving it greater leverage on the hull the mast was tilted more and more forward until it projected far over the bow. From this bowsprit a small square sail was spread, called, later, a spritsail, and this development began to make real sailing ships of ships that formerly had used sails for little more than auxiliary work.

But the Dark Ages ruined everything, and it was not until the Crusades later re-introduced the people of northern Europe to those of the Mediterranean that the northerners, who later became the greatest seamen the world has ever seen, began to get away from the Viking influence in the building of ships.

But once the shipwrights of England and Holland and France began to see the advantages of even the crude ships that were occasionally sailed by the Venetians and the Genoese to the bleak northern waters, the improvement in northern ships began.

The single mast with its simple square sail was supplemented by another mast and by the slanting mast at the bow that became the bowsprit, and it became the custom in northern waters, as it already was the custom in southern, to use two or three masts carrying square sails and one mast carrying the triangular lateen sail.

The bowsprit was a crude affair but was highly important,

which was the reason for its continued use despite the fact that even in ordinary weather in the open sea the pitching of the dumpy hulls often drove the spritsail into the waves. Perhaps this troublesome feature of the spritsail was partially reponsible, as the desire for more head sails certainly was, for the addition at the end of the bowsprit of a short, vertical spar on which a new sail called the "sprit topsail" was spread. In heavy weather this sail could be carried without plunging it into the sea long after the spritsail, which was spread on a spar mounted below the bowsprit, had to be taken in.

And now the masts of these ships began to undergo an important change. Hitherto a mast was simply a long sturdy spar made of a single tree, with a single square sail mounted on a single yard. The desire for more canvas led at first to the setting of a triangular sail above the square sail. This new sail was set with its lower corners made fast to the extremities of the yard and with its apex at the apex of the mast. Soon, however, a short yard appeared at the top of this sail, which in the course of later developments became more and more rectangular until finally it became the highly important topsail of the square-rigged ships of to-day. As still other sails were added this topsail became the sail that is carried for a greater part of the time than any other of the square sails, for in heavy weather it is the last to be taken in, and continues to hold its place long after its predecessor, the great square sail below it, has been furled.

So successful was this topsail that ship-builders and sailors began to think of ways of making it larger. Its size was limited to the height of the mast above the great square mainsail. At first masts were cut from taller trees, but soon a practical limit to this method of securing additional height was reached, because of the limited size of trees. Then it

was that the topmast was invented. Another mast, only slightly smaller than the first, was lashed with its base overlapping the top of the mainmast, which, because the upper part was now of no use, was again shortened. This proved satisfactory, and later another section and another still was added until the mast had grown from one simple spar into a structure made up of three or four or even five rising one above the other until, in the greatest of all square-rigged ships—the *Great Republic*, built in 1853—the mainmast, surmounted by the topmast, the topgallant, the royal, and the skysailmasts, towered almost half as high above her keel as the summit of Washington Monument stands above its concrete base. But that was long years after the times we are discussing, and such a ship was far beyond even the imaginations of the shipwrights and sailors of 1500.

Years before this time, as I have already explained, ships had developed raised structures at bow and stern, called forecastles and sterncastles, and by now these had become integral parts of the hull. But the hulls! It can be said with little fear of contradiction that they had become the most ridiculous ships, in appearance at least, that ever sailed the seas. Their sterns were built up and up into huge structures that contained many decks and many cabins. Forward these ships, more often than not, ran their ridiculous noses down until it sometimes seemed as if they were inquisitive to learn what was beneath the surface of the water. Above these weird hulls were three or four towering masts, and forward was a long bowsprit that reared itself up at so steep an angle as to suggest that it feared that the bow, at the very next moment, would surely go completely beneath the sea.

The mast farthest astern—which in a three-masted northern ship was then and still is called the mizzenmast—for many years carried only a lateen sail. Finally, however, the

part of this triangular sail that ran forward of the mast was eliminated, although the spar itself was still the same. But finally this long spar was cut off where it met the mast, and it became the gaff of the sail that now is called, on square-rigged ships, the spanker. On this mast, too, above this lateen sail that, pollywog-like, was losing its tail in its growth into a spanker, it slowly became the custom to set sails similar to those which on the other masts had come into common use above the great square sails that were set nearest to the deck.



THE AMARANTHE

A British warship of 1654. This ship is an excellent example of the ships that were in use just before the jib began to put in its appearance. The lateen sail on the mizzenmast is similar to the one used on the caravels, but both the rigging and the hull are greatly refined as compared with the ships of the time of Columbus.

CAMP SIBERT

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This growth, of course, was slow. The life of a single sailor was not enough to see the general acceptance of more than one or two of these steps, for seamen are conservative when it comes to changes in their ships, and are not given to the rapid acceptance of revolutionary improvements. But by comparison with the slow development of the preceding thousand years changes were coming with almost breathless speed.

It was during this period that another important improvement was introduced. I have explained how, on cruder ships, it was the custom, when more sail area was needed, to lace a separate strip of cloth to the foot of the great square sail. This extra piece of sail was called the "bonnet" and sometimes another similar piece called the "drabber" was laced to the foot of the bonnet. If the wind increased until less sail was desired these two extra sections of the sail were unlaced and the sail area was reduced by that much. In earlier times the sail was sometimes puckered up by passing lines over the spar and tying them so as to make the sail into a bundle more or less loosely tied, depending on how much or how little the sail area was to be reduced. But now came the introduction of "reef points" which, down to the present day, are still the accepted method of reducing sail.

Reef points are short pieces of rope passing through the sail. The ends are allowed to hang free on opposite sides of the canvas. On square sails there are two or three rows of these running across the upper part of the sail. When the captain orders sail reduced the men go into the rigging, lie out along the yard supporting the sail to be reefed and pulling the sail up until they reach the first row of reef points, proceed to tie the two ends of the points together over the top of the sail. This ties a part of the sail into a small space, reducing by that much the area spread to the wind.

This great improvement, together with the new arrange-

ment of sails, began to make sailing ships into structures that, more or less, were reaching out toward the perfection that led ultimately to such speed and ease of handling as never before was thought possible.

The topmasts, topgallantmasts, and others, too, by this



A 16TH-CENTURY DUTCH BOAT

It was on boats of this type that the jib seems first to have been used. To-day in Holland one sees a similar boat, called a schuyt, which is almost identical with this, except that it utilizes a curved gaff at the top of the mainsail.

time were no longer being lashed rigidly in place but were being arranged so that they could be partly lowered by sliding them lengthwise through their supports.

All this time hulls were improving, and the ridiculous sterncastles finally reached their climax and began to recede. And then came a new development that gave the builder

of ships the final thing they needed, so far as the sails themselves were concerned, to make possible the ultimate perfection of sailing ships. This was the adoption, in place of the awkward spritsails and sprit topsails, of the triangular "jibs" and staysails that are a conspicuous part of most modern sailing vessels.

Perhaps this highly efficient triangular sail did not spring, Minerva-like, fully formed, from the head of any mediæval ship-designer. It first appeared in use on small boats, and perhaps appeared there in triangular form because of the impracticability of mounting a bowsprit capable of carrying the common but awkward spritsail. Another reason, perhaps, for its triangular form, was the fact that the stay leading from the bow to the masthead, while it lent itself to holding a sail, caused any such sail to be triangular in shape because of the angle at which the stay was stretched.

Nor was a triangular sail in itself a change from the old order of things. For more than two thousand years the lateen sail had been in use, and a lateen sail is much the same shape as a jib or a staysail. Its principal difference lies in the fact that its direct support is a spar, while the support of a jib is a rope which serves also as a support for the mast. And so it is easy to imagine some old Dutch sailor—for the jib appeared first in Holland—rigging up a kind of makeshift sail on his fore stay, seeing that, because a lateen sail worked astern, another sail so similar in shape might work at the bow. Perhaps he was laughed at for his pains, for sailors are sensitive to appearances and a triangular sail at the bow of a boat in the early 16th Century was different from anything to which sailors were accustomed, and consequently, in their eyes, was, no doubt, ridiculous. But the "ridiculous" sail proved efficient, as sometimes happens in other things, and because of its efficiency and its simplicity it began to take its place as an accepted form.



A CORVETTE OF 1780

This ship shows the new sail plan overcoming the old. The masts carry topsails, topgallantsails, and royals, and what was formerly a lateen sail on the mizzenmast has become a spanker. Furthermore, while the ship carries jibs, she has not yet parted with her spritsails.

All this description of its origin is, of course, purely imaginary. I have no information as to how it originated, but I offer the explanation I have given as a plausible surmise. The earliest actual representation of a ship using this sail is, so far as I can learn, on a map sent in 1527 from Seville by one M. Robert Thorne to a Doctor Ley. On this map, like so many of its time, there are numerous decorations and pictures. One of these is a small craft, Dutch in appearance, which carries a combination of sails not unlike those of a simple sloop of to-day. It is somewhat as if a lateen sail had been cut in two vertically a third of the way back from the forward end, and the two pieces mounted separately—the triangular section depending from the fore

stay, and the remainder from a spar similar to what we now call the gaff. This interesting old map was called to my attention by a mention of it made by E. Keble Chatterton in his "Sailing Ships and Their Story."

But this triangular sail, while it was in common use from so early a date on small boats, did not appear on ships of the larger sizes until the latter part of the 17th Century and the first part of the 18th. At this time the lateen sail was still in evidence although it was beginning to undergo the first of the changes I have mentioned, while the fore and main-masts now commonly spread two square sails, and sometimes three; and sometimes, too, this third sail, instead of being square, was triangular, as the earliest topsails had been.

But the latter part of the 17th Century brought the first real steps in scientific design. Men began to study the disturbances set up by the passage through the water of various shaped hulls, and began to replace rule-of-thumb methods of design with designs based on more or less scientific conclusions. This also began to show itself in the design of masts and spars and sails. Long since, the steering oar, which for centuries was mounted on the starboard or right-hand side of the ship near the stern, had given way to the rudder, hung astern as rudders are still hung, and now the science of ship design began the steps that ultimately resulted in the *Flying Cloud* and the *Great Republic* and those other clipper ships that in the 19th Century set records for speed that many of our steamships of to-day cannot equal.

Throughout the 18th Century ships were gradually improved along these scientific lines until, in the merchant service, the beautiful ships of the British East India Company, with their piles of snowy canvas, their shining teak-wood rails, and their graceful spars, were the proudest ships that had ever sailed the seas. In the naval services the greater ships had taken a less beautiful form but had grown

into the impressive if awkward line-of-battle ships of which an excellent example is still to be seen in the *Victory*, Nelson's famous flagship, which the British still proudly, and properly, maintain at Portsmouth.

But now begins the super-perfection of sailing ships—the development of the clippers, those beautiful structures of wood and iron and canvas that for a brief time so surpassed every other ship on every sea as to set them apart in an era of their own. These were ships of such beauty and speed and spirit that they stand clearly separate and alone.

CHAPTER III

THE PERFECTION OF SAILS—THE CLIPPER SHIPS

IN THE 17th Century a new people began to make their mark in the world of the sea. Formerly the development of ships had been almost exclusively, at least for two thousand years, in the hands of Europeans—the Mediterranean peoples first, and later, the peoples of northern Europe.

One of the important reasons for the north European interest in ships had come about as a result of the discovery of the New World and, with that, the discovery that the world was actually round. That dynamic age now often called the age of discovery opened up new lands that lent themselves to colonization, and because Europe was filled with energy and was in a proper frame of mind to take advantage of the opportunity, important colonies sprang up in the Americas, in the Pacific, and in Africa.

From the point of view, however, of influences on the development of ships these colonies, in themselves, had, with one exception, little effect. This one exception was the row of British colonies that lined the Atlantic Coast of North America from the Bay of Fundy to Florida. Here there began to grow up a people whose forebears had known the boisterous seas of northern Europe, and who were scattered along a narrow coastline where they found ready and at hand the best timber in the world from which to build ships. Furthermore, the fisheries of this coast were rich, and, too, traffic between these colonies soon sprang up and demanded ships to carry it, for roads were either bad or were non-existent and the great boulevard of the sea lay outside

the entrances to the numerous fine harbours that indented the coast.

At first, naturally enough, the ships that were built were small, but by the beginning of the 18th Century the business of building ships was an important one, particularly in New



A BRITISH EAST INDIAMAN

These merchant ships, which sailed from England to the Far East, were almost as much like warships as they were like merchantmen. They were finely built, but they took their time on their voyages out and back.

England. So important was it, and so well and so cheaply were ships built in this new part of the world, that Europeans found it to their interest to buy ships from the many yards that dotted this coast. This business continued to increase in the American colonies until, in 1769, according to Arthur H. Clark, in "The Clipper Ship Era," 389 vessels, of which 113 were square-rigged, were built. All of these, it is true, were small, none of them being over 200 tons, but the busi-

ness was flourishing and valuable experience that later proved of great importance was being secured.

During this same time "The United Company of Merchant Venturers of England Trading to the East Indies," or, as it was later generally called, the East India Company, was gradually developing, for the long voyages from England to the East, those magnificent ships that now are universally referred to as East Indiamen.

So lucrative was the trade that these ships were engaged in, for it was a carefully controlled and legalized monopoly, that truly great amounts of money were made for the stockholders of the company and for the officers of the ships. And because the trade was exceptionally profitable these ships were wonderfully built and cost sums that, for those days, were huge. The ships, because they were navigating waters frequented by pirates and might be called upon to fight their way both out and back, were almost ships of war, and the discipline on board was more like the discipline of ships of the British Navy than like that of ordinary merchant ships. The crews were spick and span in neat uniforms. The men were drilled as carefully as man-of-war's-men, and the crews were large, and consequently their work was not hard.

The ships themselves were built in the finest possible manner, and the cost of one 1,325-ton ship built for this service is said to have been more than a quarter of a million dollars—£53,000 to be exact—a sum truly huge for those days, and one not exactly to be sneezed at to-day.

This great company, with its monopoly that sometimes made it possible for a ship to earn 300 per cent. on her entire cost in a single round trip from England to India or China, was organized in 1600. The fact, however, that there was no competition for them to face resulted in a conservative outlook that made for slowness rather than for speed, and

little actual advance in the science of design of either hulls or sails came as a result of the building of these costly and sturdy ships.

For two and a third centuries, however, this grand old company continued, and during that time many a fortune was built up for the investors, but finally the people of Britain rebelled at this monopoly, and Parliament, in 1832, withdrew the charter and threw open the trade to the East to other British lines.

But the conservatism of the sea is strong, and, while other lines took advantage of the opportunity to send their ships



A BLACK BALL PACKET

Ships of this type carried the transatlantic passengers of the early part of the 19th Century. Because of the demand of the owners of the Black Ball Line and of its competitors, America, where these lines were owned and where their ships were built, developed the designers who ultimately gave the world the clipper ships.

to the East they patterned them more or less after the ships of the East India Company, and little effort was made to secure speed.

But later, in 1849, the Navigation Laws which limited trade between Great Britain and her colonies to British ships, were repealed, and foreign carriers were, for the first time, permitted to enter this lucrative field.

This was the end of one act and the beginning of another, for the repeal of these laws gave the opportunity it needed to that new country, now a nation, that for two hundred years had been teaching itself to build ships of the trees from the rocky soil of New England.

But a little more is needed to understand just why the ship-builders of the United States of America were in a position to leap so suddenly into prominence among the carriers of ocean freight.

For two hundred years, as I have said, Americans had been building ships, and in that time the industry had had its ups and downs. British legislation, in colonial days, had had its adverse effect. The Revolutionary War, and, later, the War of 1812, had dealt disastrous blows at American shipowners, but these people were of seagoing stock, and each time they recovered. Then, after the War of 1812, and particularly after the long Napoleonic struggle was brought to an end in 1815, trade between the new American nation and Europe, and particularly between America and Britain, developed by leaps and bounds.

International commerce grew as it had never grown before, and, shortly, lines of "packets"—that is, passenger ships running regularly between two ports—went into service between Britain and America.

The Black Ball Line was the first of these. Its ships were distinguished by a large black circle on the foretopsail below the close reef-band, where it would be visible as long as the



A WHALING BARK

With a lookout at the masthead these ships cruised all over the earth in the first half of the 19th Century.

ship carried even a shred of sail. The earlier ships of this line were from three hundred to five hundred tons, and before long more than a dozen were in service. They sailed regularly and for the first ten years of the line's existence averaged, according to Arthur H. Clark, twenty-three days for the voyage east, and forty days for the return, the discrepancy between these two being due to the prevailing winds of the North Atlantic which, on the route these ships sailed, are from the southwest. The Gulf Stream, too, or rather the continuation of the Gulf Stream, sometimes known as the Gulf Stream Drift, aided them on their eastward voyages.

During the thirty years following the founding of the Black

Ball Line a number of other similar lines were founded, notably the Red Star Line, the Dramatic Line, and the New Orleans Line from New York. All of these, and others, were American owned, and with the opening of the Erie Canal, which gave access to the Great Lakes, and opened a vast new land, trade greatly increased.

These ships were not large at first, but gradually they increased in size until, in 1849, the *Albert Gallatin*, of 1,435 tons, became the largest of the lot, although a number of others approached her in size.

These ships were in a new kind of service. Before the origin of the Black Ball Line there had been few passenger ships. More often than not ships had accommodations for passengers, as the East Indiamen had, but ships had seldom, prior to the opening of the 19th Century, devoted much space to passengers. In a later chapter I shall discuss the reasons for this. But once ships began to carry passengers to the practical exclusion of freight, speed became desirable, and the North Atlantic packets were designed more and more with speed in mind. This resulted in a demand for really scientific naval architects and because Americans were the ones chiefly interested in building faster ships, and because, too, the packet lines could afford to pay for their services, able men turned their attention to this important problem.

Thus it was that, between 1816 and 1849, a demand on the part of the American packet lines for faster ships produced in America a group of designers who evolved a type of sailing ship that the world has never seen surpassed for speed on the wide stretches of the open sea. And thus it was, too, that with the repeal of the Navigation Laws in England, America was able to put into service between Britain and the Far East such ships as made conservative British seamen gasp for breath ere they, too, set about follow-

ing, with eminent success, in the footsteps of their transatlantic brothers. Then, instantly, the gigantic rush of gold hunters to California gave added impetus to the demand for faster ships, and almost overnight the era of the clipper ship had begun.

According to Arthur H. Clark's "The Clipper Ship Era,"



THE RED JACKET

A clipper ship that made one of the fastest voyages across the Atlantic ever made under sail. Her record from Sandy Hook to Rock Light was thirteen days, one hour.

which contains a complete and fascinating account of this whole period (and it is actually a story for a book rather than for a mere chapter into which it is impossible adequately to compress it), the first clipper ship ever built was the *Ann McKim*, a ship built at Baltimore in 1832.

During the War of 1812 a number of Chesapeake Bay ships which came to be called "Baltimore clippers" proved very successful as privateers. These ships were fast, and probably the name "clipper" had some connotation at the time

suggesting speed. But these "Baltimore clippers" were not, as the word was later used, clipper ships in the true sense. The *Ann McKim*, as I have said, was actually the first of these.

This ship was an enlargement to scale of one of the small, fast sailing vessels which two hundred years of ship-building experience had taught American shipwrights to construct. The *Ann McKim*, then, was a small sailing ship built by the foot, so to speak, while her smaller counterparts had been built by the inch. Her proportions were identical to those of the small fry that skimmed about Chesapeake Bay. Only in size and in the elaborateness of her finish did she differ.

Before the advent of the *Ann McKim*, no one seems to have thought of building a ship of her size—she was 143 feet long—on any lines but those which for so long had been accepted as proper for a ship, and they were far different from the lines accepted for small boats. But despite her originality the *Ann McKim* proved to be fast.

It seems to be true that this ship did not directly affect ship design. But in the next nine years a number of fast ships appeared, and then John W. Griffiths, a young naval architect of New York, in a series of lectures on the subject of ship design, laid down the basic rules that brought into being those beautiful ships—of which there were never more than a handful, by comparison with the other ships of the world—that suddenly leaped into world-wide prominence.

To the uninitiated, the changes proposed by Griffiths seem unimportant and perhaps uninteresting, for it resulted only in sharper bows and finer lines, in the movement, farther toward the stern, of the ship's greatest beam, and of "hollow" water lines—that is, the curve of the hull aft from the bow along the water line was concave before it

became convex, as it long had been for its whole length on other ships.

The first ship to be built along these new lines, and therefore the first clipper ship of the new order of things, was the *Rainbow*, which was launched in 1845. It is interesting, too, to note that, while she was lost—perhaps off Cape Horn—on her fifth voyage, few of the later clippers ever broke the records she set. Griffiths, with the touch of genius that he had, had instantly approached such perfection as mortal man can reach.

And unlike the *Ann McKim*, the *Rainbow* did affect ship design. It is true that critics announced that these new ships would capsize from the very weight of their spars, that they could not stand up in a boisterous sea, that they



THE GREAT REPUBLIC

The greatest clipper ship ever built. Unfortunately, before she made her first voyage she caught fire and had to be sunk. She was refloated and refitted, but never made a voyage in her original rig. When new masts were put in her they were made smaller than the first ones. Still she turned out to be one of the very fastest of the clippers.

were freakish and ridiculous. But still they were built, and there were races out to China and back again; and sometimes they brought to New York the news of their own arrivals at Canton or Shanghai.

So quickly had Griffiths's ideas of ship design taken hold that in the four years from the launch of the *Rainbow* until 1849—when the repeal of the Navigation Laws permitted foreign ships to compete for business between Britain and her colonies and the rush to California opened up another profitable field—a number of these new clipper ships were making regular voyages.

The story of the first American clipper ship to carry a cargo of tea to Britain from China is an interesting one, and I can do no better than quote directly from Mr. Clark's account of the voyage in "The Clipper Ship Era."

"The *Oriental*," says Mr. Clark, "sailed on her second voyage from New York for China, May 19, 1850 . . . and was 25 days to the equator; she passed the meridian of the Cape of Good Hope 45 days out, Java Head 71 days out, and arrived at Hong-kong, August 8th, 81 days from New York. She was at once chartered through Russel & Co. to load a cargo of tea from London at £6 per ton of 40 cubic feet, while British ships were waiting for cargoes for London at £3:10 per ton of 50 cubic feet. She sailed August 28th, and beat down the China Sea against a strong southwest monsoon in 21 days to Anjer, arrived off the Lizard in 91 days, and was moored in the West India Docks, London, 97 days from Hong-kong—a passage from China never before equalled in point of speed, especially against the southwest monsoon, and rarely surpassed since. She delivered 1,600 tons of tea, and her freight from Hong-kong amounted to £9,600 or some \$48,000. Her first cost ready for sea was \$70,000. From the date of her first sailing from New York, September 14, 1849, to her arrival at London, December



THE ARIEL, 1866

Which, with the Fiery Cross, Taeping, Serica, and Taitaing, sailed what was, perhaps, the greatest race ever run. After sailing 16,000 miles from Foo-Chow, China, to London, the Ariel, Taeping, and Serica docked in London on the same tide, the Taeping the winner by only a few minutes. The other two were only two days behind, although the first three took 99 days.

3, 1850, the *Oriental* had sailed a distance of 67,000 miles, and had, during that time, been at sea 367 days, an average in all weathers of 183 miles per day."

Such performances were not rare for these ships, and because they were the rule, rather than the exception, the reputation of clippers grew apace, and interest rapidly grew in their comparative speed. Thus it was that many races were sailed, half around the world, during which every stitch of canvas possible was carried for every mile of the way, and captains studied winds and currents with such care and success that well-matched ships were often in sight of each other off and on during voyages of thousands of miles.

The development of the clipper ship was rapid, and her decline was almost equally fast. Eight years after the

Rainbow took the water Donald McKay, an able designer and builder, launched the *Great Republic*, one of the very largest sailing ships ever built. While this ship has been surpassed in size by several later sailing ships, no other ship ever built was designed to carry so enormous a press of sail.

The mainmast of this great vessel was a huge "stick" 131 feet long and 44 inches in diameter. Above this were the topmast, 76 feet long; the topgallantmast, 28 feet long; the royalmast, 22 feet long; and the skysailmast, 19 feet long. All of this was topped by a 12-foot pole. The great structure of the built-up mainmast towered more than 200 feet above her deck.

But this greatest of all sailing ships was destined never to take a voyage with these gigantic masts and spars. Just after she had finished loading in New York for her first voyage, a warehouse fire ashore dropped embers in her rigging and she was so badly burned that she was sunk in order to save what was left. Her beautiful masts had had to be cut out of her during the fire, and when she was finally raised and rebuilt freight rates had fallen so far that it was not thought best to re-rig her in her original dress. A reduced rig was installed, making possible a great reduction in the size of her crew, but even with her reduced rig she crossed the Atlantic from Sandy Hook to Land's End in 13 days.

Until the Civil War broke into the peaceful development of America, clipper ships were built in many yards, although the introduction of iron as a ship-building material was giving Britain the upper hand again, after the Americans had temporarily wrested it from her. This introduction of iron in itself would have caused the elimination of America from mid-19th Century ship-building, but the Civil War laid a heavy hand on the young country, and American ships largely disappeared from the sea, save along the Confederate coast where great fleets lay in wait for fast blockade runners

that slipped out to Bermuda and the Bahamas for cargoes of European goods to take through the blockade to the needy South.

England, however, had once more found herself, and soon her yards were building clipper ships that equalled the



A GLOUCESTER FISHERMAN

Such schooners as this are common in the New England fishing fleets. They are seaworthy and fast, and probably the men who sail them are the greatest seamen of our time.

Americans—surpassed them, some say, but more than one challenge for an ocean race was issued by groups of Americans only to find no takers in British shipping circles. Now and then, it is true, British ships outsailed American. But now and then, too, Americans outsailed their transatlantic brothers, so it is difficult to decide as to their relative merits.

But there is no doubt of one thing—the greatest ocean

race ever sailed was one in which five British tea clippers were engaged. The *Ariel*, *Taeping*, *Fiery Cross*, *Tailsing*, and *Serica* sailed from Foo-chow, China, within two days of each other, on the 29th, 30th, and 31st of May, 1865, all bound for London. Forty-six days later the *Fiery Cross* rounded the Cape of Good Hope, followed by the *Ariel*, which also made that meridian in forty-six days; the *Taeping* in forty-seven days; the *Serica* in fifty days; and the *Tailsing* in fifty-four days. Through June and July they sailed, and on August 9th the *Fiery Cross* and *Taeping* sighted each other. The ships passed the Azores in the following order, *Ariel*, *Tailsing*, *Fiery Cross*, *Serica*, and *Taeping*, all closely grouped. From there to the English Channel the race continued, with each ship unacquainted with the position of the others, save occasionally when their courses brought them together. Yet on the morning of September 5th, two of these ships sighted each other as they entered the English Channel. As they came closer together each recognized the other—they were the *Ariel* and the *Taeping*, which had left Foo-chow within twenty minutes of each other more than three months before. Up the Channel they raced, side by side, and on September 6th, these two ships, and the *Serica*, which had sailed up the Channel four hours behind them, docked in London on the same tide and all three of them within an hour and forty-five minutes of each other, the *Taeping* the winner by a few trifling minutes. Nor were they far ahead of the other two, which docked on the 7th and 9th. Three ships had sailed 16,000 miles in 99 days, and the other two in 101. Never before or since has a long ocean race shown such evenly matched ships.

But the days of the clipper ships were numbered. Steam was already making inroads, and when the Suez Canal was opened in 1869, steamships could make the voyage to the East through the narrow waters of the Mediterranean and

the Red Sea, where sailing ships were impotent to follow, in much less time than even the clippers could round Cape Horn. And so there passed from the sea what were probably the most beautiful of all the ships that ever sailed its dark blue surface. Yachts there may be whose fragile lines are just a bit more delicate, whose sails are bleached more white. But such comparison is odious. It is as if Du Barry were compared with Juno. Now and again a watchful eye may still see a square-rigged ship being impudently towed about some teeming harbour by some officious tug, and occasionally a fortunate voyager may see one with her sails set as she harnesses the wind to take her half across the world. But the romantic days of sail have gone. The voyages from



AN AMERICAN COASTING SCHOONER

Square-rigged ships have largely disappeared because, among other things, their crews were large. These schooners, which sometimes have four or five masts, can be handled by small crews and consequently are able to continue to vie with steam.

London to China around Good Hope, from New York to San Francisco around the Horn—they are things long past. Steam and a ditch through the sandhills of Suez did it. And now another ditch through the hills of Panama has double-locked the door, and sail is gone.

But hold! Sail is nearly gone, and yet it is here!

No more do fleets of monster ships with towering masts spread square sail after square sail to the honest winds of heaven. They, it is true, have almost disappeared, and what is left is not to be compared with what is gone. Yet in these days of steam and coal, of grimy stokers and machines *called* ships, there still remains, to gladden the eye of the white-haired men who sailed the clipper ships a half a century and more ago, a type of sailing ship that has proved to be so handy, so capable and efficient, that all the machines of a machine-mad world have not been able to drive them from the sea.

These are the schooners and the other craft whose sails, based on those old Dutch vessels that first used the jib, are of a different design.

The clipper ships and their predecessors were "square-rigged" ships. A schooner is a "fore-and-aft" rigged ship, and to-day the "fore-and-aft" rig is the only rig in common use.

It will have been seen, from this account, that the development of sails was slow. Century followed century and ships progressed but little. Even the most rapid period of development covered the four centuries, from 1450 to 1850, so that, while fore-and-aft sails have reached their present stage more rapidly than square-rigged ships, still the story is one that covers centuries.

I have already told of the origin in Holland of the jib, which seemed to grow out of the lateen sail. It was from that beginning that the "fore-and-aft" rig developed.

The narrow waterways of the low countries demanded a type of sail that could be handled more easily and could sail closer to the wind than the square sail could. This the fore-and-aft sail did, and so it filled an important need. I have not the space, in what remains of this chapter, to trace its growth in all its detail. Furthermore, E. Keble Chatterton has done so admirably in "The Story of the Fore-and-Aft Rig."

Let it suffice to say that the growth has been more a perfection than a series of revolutionary changes. At first the rig was crude. The sails were laced to the masts, for hoops sliding on the mast and to which the sail is made fast, while now almost universal, were then unknown. A boom was used to spread the foot of the sail, but not until the famous yacht *America* crossed the Atlantic and won the cup that still is held in America as the greatest racing trophy in the world was the foot of the sail laced to the boom.

Many times I have sat at the wheel of the *America* as she lies in the basin of the U. S. Naval Academy at Annapolis, her masts denuded of the pile of canvas that drove her to that famous victory, and thought of her and of the little group of men whose careful thought resulted in her triumph. Such men as those, in the thousands of years through which ships have grown, have been the men who have made possible the growth of the dugout canoe with its sail of skin into the *Great Republics* and the *Americas* and, later, the *Majestics*. Such men as those have aided greatly in the advance of civilization.

I have space here for but one more thing. The Dutch, as I have said, were responsible for the origin of the fore-and-aft rig, and Europeans largely developed the yawl, the ketch, the brig, and several other forms that use fore-and-aft sails. But schooners are the most numerous of these and they originated, as their name did, in a New England shipyard.

The story is an old one and well known, but I shall include it here, for it is the only case of which I know in which a new ship form together with its name appeared so abruptly.

It was in Gloucester, Massachusetts, that port now famous for the ablest schooners that sail the seas, that the schooner originated. In 1713 an ingenious builder built a boat and placed in her two masts bearing fore-and-aft sails. For a head sail he spread that triangular canvas now so common, but this was the first time that these sails, all long familiar, had been arranged according to the now common plan.

She left the stocks and floated lightly on the water, and an interested spectator cried, "Look! She how she scoons!"

The owner must have been a man of wit as well as originality for he replied: "Very well. A scooner let her be." And schooner she still is, but in the two centuries since that time her form has impressed itself on many thousand ships, and the port that gave her birth has gained a reputation that is world-wide as the port of the ablest schooners and the ablest sailors that ever graced the great expanse of ocean.

CHAPTER IV

THE DEVELOPMENT OF STEAMSHIPS

FROM the day a really successful steam-driven vessel first moved herself awkwardly in the water until the *Majestic* slid from her German ways was not much more than a hundred years. But that hundred years shows more of progress in the development of ships than the preceding thousand. So breathlessly rapid has been the development of steamships that there are men still alive who remember them as frail experimental craft upon which little dependence could be placed. "Sail," said the citizen of a hundred years ago, "is a dependable mode of propulsion. Steam is a ridiculous power, or at best a dangerous and highly experimental one."

"Steam," says the "landlubber" of to-day, "is satisfactory for me. Sailing is a foolhardy business."

And neither the century-old viewpoint nor the new one is entirely right.

Steam was vaguely recognized as a source of power even in early Egyptian history, and several times before the birth of Watt inconsequential experiments were made with it.

There is a story, not now accepted as true, of one Blasco de Garay, who in 1543 experimented at Barcelona, Spain, with a boat propelled by steam. It was not for another 100 years, however, that steam was practically applied. But as early as 1690 it is known that Thomas Savery and Denis Papin proposed the use of steam as an aid to navigation. Papin even built a model boat in which a crude steam engine

was installed. A man named Newcomen seems to have been the builder of the engines used in these and other early experiments. One engine built by this experimenter was used in 1736 in a boat built by Jonathan Hulls in England.

That great American, Benjamin Franklin, whose genius touched such a diversity of subjects, saw, as early as 1775, that paddle-wheels were inefficient machines, and called attention to the fact, suggesting that an engine be devised to draw a column of water in at the bow, to project it forcibly astern in order to give the ship headway. This method was tried but before much success had been attained, all engines being of such low power, the screw propeller had been perfected and the water-jet system was dropped, although in 1782 James Rumsey built a boat of this type on the Potomac. In France a steamboat built by the Marquis de Jouffroy is said to have been operated in 1783. This boat was 150 feet long and ran with some degree of success for about a year and a half. Jouffroy has sometimes been given credit for the invention of the steamboat. In 1788 a small vessel of strange design was driven at four or five miles an hour by William Symington in Scotland. This boat was built at the expense of a Scotch banker named Patrick Miller. Two years before this John Fitch, a New Englander, built a fairly successful steamboat that was propelled by steam-driven oars. Symington's experiments were continued and another boat that made seven miles an hour was running in 1789. Still more successful was another of Symington's boats, the *Charlotte Dundas*, when, in 1802, she towed two loaded vessels, totalling nearly one hundred and fifty tons at three and one-half miles an hour for a score of miles in the Forth and Clyde Canal. The project was abandoned, however, because of the effect of the agitated water on the banks of the canal. The *Dundas* was, of course, driven by a paddle-wheel. Symington continued his efforts but was



THE CHARLOTTE DUNDAS

Before the Clermont was built, this boat had operated successfully on the Forth and Clyde Canal in Scotland. The objection to her was that she stirred the water up so that she injured the banks of the canal.

unfortunately handicapped financially, and when Lord Bridgewater, his next backer, died, he withdrew from the field, reduced to poverty.

But all of these were merely preparatory to the first steamboat that is to be accepted as a thoroughly practical affair. In 1807, after several years of travel in Europe where he inspected all the steam engines of which he could learn, and where he experimented with a steamboat of his own design on the Seine, Robert Fulton built the *Clermont* in New York. Her engine, or at least the major part of it, was built in England and shipped to New York where it was installed in the first definitely successful steamboat ever built. The *Clermont* was 133 feet long and 18 feet wide, and made the run from New York to Albany, a distance of about one hundred and fifty miles, in thirty-two hours.

But the *Clermont* had a greater task in the breaking down of prejudice than ever she had in propelling herself through the smooth waters of the Hudson on her round trips between New York and Albany.

The first steamer to make an ocean voyage was a boat named the *Phoenix*, built in 1809. She was driven under her own power from Hoboken, New Jersey, on the Hudson River, opposite New York City, to Philadelphia.

So rapid was the increase in the number of steamboats that by 1814 a contributor to the columns of the *Gentlemen's Magazine* wrote that "most of the principal rivers in North America are navigated by steamboats. One of them passes 2,000 miles on the great river Mississippi in twenty-one days, at the rate of five miles an hour against the descending current," which, if true, tells a dramatic story of the rapid development of this new apparatus.

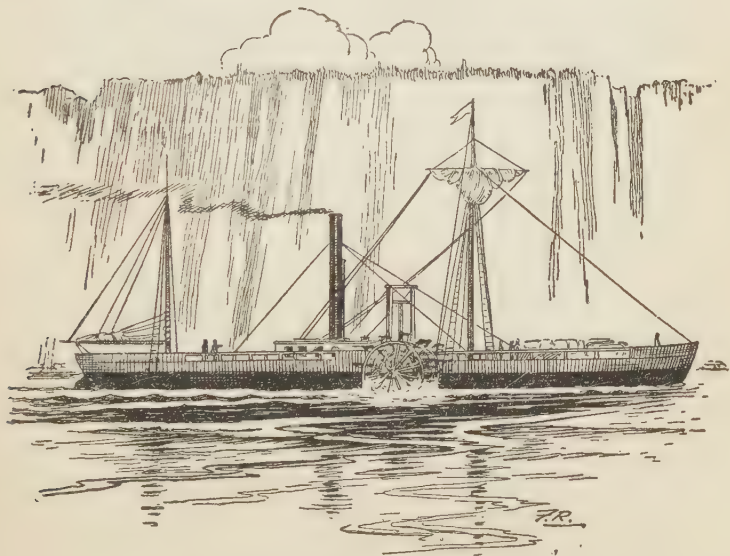
During the next decade a number of boats and small ships were built, in the hulls of which steam engines were placed, and on the masts of which the ever-present sails were spread to guard against what were, evidently, the inevitable breakdowns. But another step in the development of steamships was to be made. Up to 1818 steam-driven ships had been used only on inland or on coastal waters. But in that year a 380-ton full-rigged ship was built in New York City and was equipped with paddle-wheels operated by a steam engine of seventy-two horse power. (Some say this engine developed ninety horse power but the measurement of the power of engines was then at best an inaccurate science.)

After a number of trials, this ship, which was named the *Savannah*, crossed the Atlantic in 1819 taking twenty-five days from Savannah, Georgia, to Liverpool. The passage attracted much attention, even though the ship had been under power for only a part of the time. This did not

prove, however, that her engines were not capable of more extended operation. They were stopped for the excellent reason that the fuel ran out. While this voyage created widespread interest it also suggested to the wits of the day the necessity for a fleet of sailing ships to accompany the steamers of the future in order to keep them supplied with fuel.

Later, when the *Savannah* returned to America, her engines were removed, but she had served a useful turn, and she is accepted as the first steam-driven ship to cross the Atlantic.

With this mark to shoot at, the progress of steamships became more rapid, although for sixty years most of them that were intended for deep-sea work carried masts and spars from which sails could be spread.



ROBERT FULTON'S CLERMONT

The first completely successful steamboat ever built. Others built before the Clermont were made to go, but this ship carried passengers for years.

Confidence in steam grew slowly, and with reason, for the engines were anything but reliable, safety appliances were unknown or inadequately understood, and steam-driven vessels often broke down, or worse still, blew up. So common was this latter happening that an advertisement that appeared in an American paper enlarged upon it. The notice went on to say that there had been much talk about the explosions that had taken place on the vessel that was being advertised but that that was no cause for alarm for "not a passenger has been injured."

The engines were single-cylinder affairs, with their parts, more often than not, improperly designed and imperfectly machined. Good lubricants were unknown and proper lubrication was almost impossible, with the result that parts wore out and shrieked dismally at their treatment. The boilers were crudely made of iron, riveted together by hand, so that leaking seams were, apparently, the rule, when any pressure was generated. Pressure gauges were long in coming and the safety valves worked so imperfectly that the engineer's first notice of any excess pressure was often the bursting of a steam pipe, the further widening of a leaking seam, or, worse still, the sudden, and sometimes tragic, eruption of the whole boiler.

Then, too, another trouble affected the boilers. They were, more often than not, unprotected from the weather, and, their design being of the simplest, it was difficult, when the temperature was low, to get up enough pressure to operate the crude engines. They burned wood, at first, and ate cords of it, so that frequent stops were necessary in order to secure more fuel. There were no condensers, and so steamboats that sailed on salt water often ran out of fresh water for their boilers. Furthermore, good insulation had not been developed, and occasionally, when the perverse machines seemed ideally happy, when the cylinder energeti-

cally turned the awkward paddle-wheels with a will, to the tune of creaking bearings, clanking joints, and hissing steam, the whole vessel was thrown into a furor, the engine was stopped, the passengers and crew were forced to turn to in an effort to save the ship from some fire or other, started by a red-hot fire box, or a burning ember from the funnel.



THE SAVANNAH

The first steamship to cross the Atlantic.

Such were the difficulties that the pioneer steamboat-men had to face, and it speaks well for their patience and nerve that they hung on until improvement after improvement turned those dangerous and imperfect machines of theirs into the safe and almost flawless examples of mechanical artistry that now propel so many thousands of hulls in every part of the world.

In 1820 the General Steam Navigation Company was formed in England, and this, the first steamship company, may be considered, properly enough, a highly important in-

fluence in the development of steamships, for the merchant ships of the world are almost exclusively in the hands of lines of greater or lesser strength, and it is these lines that make possible the building and operation, and consequently the perfection, of such vessels.

In the next few years a number of steamships were built in America, in Great Britain, and on the continent, and in 1825 a 470-ton ship—the *Enterprise*—made a voyage from England to India, 11,450 miles, around Good Hope, in 103 days during but 39 days of which she was under sail exclusively. This accomplishment, together with others less spectacular, added impetus to the growing popularity of steam, and by 1830 Lloyd's Register listed 100 steamers, and there were others, particularly in America, not included in that list. The Register published in 1841 announced that in 1839, 720 steamers were owned in England, Scotland, and Ireland.

In the 'thirties steam navigation went ahead by leaps and bounds, and before the 'forties came, a steam-driven vessel—the *Great Western*—had crossed the Atlantic in 15 days, which was well under the fastest time for sailing ships of her day, and only 2 days over the fastest crossing ever made by a sailing ship. The *Red Jacket*, a clipper, crossed in 1854 from Sandy Hook to Rock Light in 13 days, 1 hour.

But with the rapid increase of steamships arose a condition due to the change in economic conditions and the widening power of Great Britain that was of the greatest value in the development of shipping and consequently of steamships.

Steam had been applied to machinery on land no less than to the propulsion of ships. Factories sprang up, railroads slowly spread their tentacles over Great Britain, the continent, and the American seaboard, and commerce consequently became more rapid. Goods were shipped in ever-increasing amounts, and the widening field of business called



THE GREAT BRITAIN

An awkward and unsuccessful ship. She proved, however, when she was wrecked, that for ship construction iron is stronger than wood, and proved, too, that double bottoms, bulkheads, and bilge keels, which were new departures when she was built, were most desirable in ships of her size.

men here and there who formerly had done what overseas business they had had through the captains of ships, or through supercargoes and agents.

Great Britain, in addition to, or perhaps because of, her growing power as a centre of manufacture and shipping, thrust out her long arms to India and China, to Australia and New Zealand. The growth of the population at home and the opportunities for colonists in America, in Australia, and other parts of the world, resulted, almost for the first time, in the construction of ships intended solely for the purpose of carrying passengers and mails. A large travelling public was, for the first time in history, beginning to appear.

In the 'forties, therefore, began a division of ships into two

major classes—carriers of freight and carriers of passengers. Sailing ships were still greatly more numerous than steamships and, as a matter of fact, the finer sailing ships were still considered the aristocrats of the sea. But as steam engines were perfected, and particularly after the screw propeller was invented by Co'onel John Stevens, an American, early in the 19th Century, and perfected by F. P. Smith, an Englishman, and John Ericson, the Scandinavian-American, steamships increased in power, in speed, in reliability, and consequently in popularity.

This period saw the beginning of a number of new steamship lines, some of which, notably the Cunard and the Royal Mail, are still in existence, although they are now operated on a scale that could never have been imagined even by their forward-looking founders.

And now, as if for the purpose of aiding this great increase in the efficiency and size of steamships, came another development, without which the leviathans of to-day would be impossible, and but for which the beautiful clipper ships which were brought so close to perfection in the middle of the 19th Century might still be supreme upon the seas, or at least might still be able to hold their own against their steam-driven sisters.

It was the rolling mill, a thing prosaic enough to-day, that made possible the great increase in the size and strength of ships. The rolling mill and the screw propeller are still the basic improvements that have led to the building of most of the ships on the high seas to-day.

The first suggestion of the use of iron plates for the building of ships was received with withering sarcasm. How could ships be built of iron when everyone knows that iron will sink? But even in the face of such criticism ships were built, and they were not only built—they were launched and they floated.

So far as I can learn the first boat to be built of iron was launched in 1777 on the Foss river in Yorkshire. Later several lighters for canal work were built, one in particular being constructed near Birmingham in 1787. Less spectacular, but still highly important, was the introduction of iron for special uses in wooden vessels. This later grew into what came to be known as "composite" construction. The year 1818 is sometimes given as a definite date for the recognition of iron as an accepted ship-building material because in that year a lighter named the *Vulcan* was built in the vicinity of Glasgow, but it is known that several iron hulls were built prior to that time. An iron steamboat named the *Aaron Manby*, after her builder, was operated for twenty years on the Seine after being built in England in 1821.



THE GREAT EASTERN

A ship that was built half a century too early. This huge vessel, built in 1857, was designed to make the voyage from England to Australia without refuelling. She never made the voyage to Australia, but was used to lay the Atlantic cable. She was ahead of her time, for engines had not developed to the point where she could be properly propelled.

She crossed the English Channel under her own power and made the trip from London to Paris. Still, however, there were many doubters, and not for more than twenty years was an iron ship of large size built. In 1843 the *Great Britain*, a ship of 3,600 tons, was built of iron, and this vessel was a notable step in the advancing art of ship-building. She was 322 feet long, 50 feet 6 inches broad, and was equipped to carry 260 passengers and more than a thousand tons of freight—surely no mean vessel, even to-day.

This ship, as a matter of fact, proved a highly important affair, for she proved many things to the wisecracks of the day. I am indebted to E. Keble Chatterton, author of "The Mercantile Marine," for his valuable story of her building and her adventures.

So great and so unusual was this ship that, according to Mr. Chatterton, no contractor could be found who was willing to construct her. Consequently, the Great Western Steamship Company constructed her itself.

She turned out, says Mr. Chatterton, to be "an awkward, ill-fated monstrosity," but despite the fact that she did not prove that the combination of screw propeller and iron construction were successful, she did prove, after she ran ashore on the coast of Ireland, where she remained for eleven months exposed to the weather, before she was refloated, that an iron hull could withstand far more strenuous strains than any wooden hull could hold up under.

This ship, furthermore, was divided into watertight compartments and was equipped with bilge keels, which are accepted to-day as an excellent method for lessening a ship's rolling.

By the time the American Civil War broke out in 1861, steam had made such definite strides that there were few to question its supremacy over sail.

The navies of both the North and the South were, except

for a few out-of-date ships, exclusively steam driven. Then, in 1862, the Cunard Line built the *Scotia*, a 3,300-ton iron steamer, driven by paddle-wheels. She had seven watertight compartments and a double bottom, the value of these having been proved by the unfortunate *Great Britain*, and she crossed the Atlantic in eight days and twenty-two hours—a record not to be ignored even to-day with the records of the *Mauretania* and the *Leviathan* before us. Many ships on transatlantic routes to-day cannot equal that record, and for the first time the outstanding records of the fast sailing ships were finally and completely outclassed.

But before the *Scotia* slid from her ways the *Great Eastern* was launched. So great was she and so unusual that she created a furor in the shipping world that even yet has not entirely subsided.

The idea of building so great a ship originated because of the desire to carry a large passenger list and a great cargo from England to Australia without having to coal on the way. This desire led to the designing of a ship of truly huge proportions. She was driven both by paddle-wheels and by a screw propeller, and was 679 feet 6 inches long, 82 feet 8 inches beam, and her tonnage was 18,900—dimensions that were not surpassed until 1905 when the White Star Line launched the *Baltic*. She was under construction for four years, being launched in 1858.

So huge was the *Great Eastern* that her engines, which were of only 3,000 horse power, were inadequate, and she never proved to be a real success, financially or mechanically, although her hull proved to be staunch enough, despite the little past experience her designers and her builders could profit by in her construction.

This great ship was equipped with six masts, each capable of carrying sail, five funnels, two paddle-wheels, and a propeller. She never voyaged to Australia, but she did cross

the Atlantic, and from 1865 to 1873 she was used for laying the first Atlantic cable. In 1888 she was beached and broken up. She, however, was ahead of her day. Engines had not developed to the point where ships of her size could be properly powered, and she merely stands for the courage and inventiveness of the mid-Victorian ship-builders who dared to undertake so vast and so new a task.

With the exception of the *Great Eastern*, however, ships increased only gradually in size, and their increases in speed were approximately parallel to their growing tonnage. The *Great Eastern* was an attempt—an unsuccessful attempt—to leap ahead half a century. But the semi-failure of this ship did not retard the growth of ships. Perhaps, even, it aided that growth.

And now again a new development puts in its appearance in the world of ships—a less spectacular one than the introduction of steam, less spectacular even than the introduction of iron, but important, nevertheless. In the 'seventies steel was first introduced as a serious competitor to iron for the construction of ships. Its greater strength and its comparative lightness were its principle claims to superiority, but so important are those that while the Allan liner *Buenos Ayrean*, launched in 1879, was the first steel sea-going ship, to-day every merchant ship (with exceptions hardly worthy of mention) is built of steel.

About this same time the White Star Line organized its transatlantic service, and in 1870 a 420-foot liner (carrying sails in addition to her engines, as was still the rule) was launched and put into service in the North Atlantic. The White Star Line had previously owned a fleet of clipper ships, but when trade between Britain and the United States increased so enormously and the trade became profitable the White Star owners decided to enter it. This first White Star liner, the *Oceanic*, may, perhaps, be called the

first of the transatlantic greyhound fleet, for in her, for the first time, there were really great concessions made with the comfort of the passengers in mind, and from her time until to-day new and improved liners have been launched in ever-increasing numbers. In 1881 the Cunarder *Servia*, the greatest of her kind save only the *Great Eastern*, was put in



THE STEAMSHIP *OCEANIC*

This ship may be said to be the first of the transatlantic liners, for in her, for the first time, great concessions were made for the comfort and convenience of the passengers.

service. This 515-foot, 7,300-ton ship was a marvel of mechanical perfection in her day and lowered the transatlantic record to seven days, one hour, and thirty-eight minutes.

One of the greatest reasons for the increased speed of these new ships was the introduction of the compound engine. It was in 1854 that John Elder, a Briton, adapted the compound engine to marine uses. This improvement, by utilizing more thoroughly the expansive power of steam, increased at one stroke the power developed by engines without in-

creasing the supply of steam. The principle of the compound engine is simple. Steam escaping from the single cylinder of a simple steam engine still retains a part of its pressure—that is, a part of its power to expand. As it is largely the expansion of the steam that forces the piston from one end of the cylinder to the other this means that a part of the useful force of the steam is wasted in the average single-cylinder engine. A compound engine, however, utilizes this power by leading the steam from the exhaust port of the first cylinder to the inlet port of another and much larger cylinder. Here the steam, now occupying more space, is used again to operate another piston connected to the same crankshaft. There is often still a third cylinder, and in some cases a fourth, in each of which some of the remaining power of the steam is utilized. The gradual increase of steam pressure in the better boilers that were being built also aided the development of these compound engines. In 1854, for instance, 42 pounds pressure per square inch was seldom exceeded, while in 1882, 125 pounds was a pressure occasionally reached.

With the development of compound engines and boilers capable of more pressure the screw propeller became even more efficient, and gradually the paddle-wheel disappeared from the deep sea. Furthermore, the compound engine, by its more economic power, made it possible for the steamer to compete with the sailing ship in the carrying of cargoes, even on long voyages, and so began the rapid growth of the cargo steamers that now have practically driven sailing ships from the sea.

And now comes a division of this subject of steamships—a division that later led to subdivision after subdivision, but which I shall treat in two major parts: steamers equipped to carry passengers, and steamers not so equipped.

The passenger steamers have gone through an amazingly

rapid growth since 1888, and have developed along many lines, but it was in that year that the first twinscrew steamers of large dimensions were put in service. The Inman liners *City of New York* and *City of Paris* were the first large ships to be so equipped. This double system of propulsion eliminated the necessity for sails on liners, and from that time on the masts of ocean liners have deteriorated to mere supports for derricks and signal spars. By this time, too, all the larger steamers were being fitted with steam steering gears. This important (and now almost universal) appliance was first installed on the Inman liner *City of Brussels* in 1869.

And now, in the late 'eighties and early 'nineties, came the forerunners of the long list of ships that have grown into the finest fleet of express steamers to be found on any of the Seven Seas. Great Britain and the United States were primarily interested in this trade, but the other nations of northern Europe also had a part to play, and even Austria-Hungary and Italy entered the competition. But the United States gradually grew to depend more and more on the ships of other nations until finally the American Line with its handful of ships was almost the only serious American contender for the profits of the rapidly growing passenger business that had developed.

But into this furious competition a new nation thrust itself. Germany had become a power—a forceful, dominating power—as was proved in the Franco-Prussian War in 1870 and 1871. And she saw that her “place in the sun” could only be gained by venturing on the sea. Government aid to shipping and an enthusiastic demand on the part of the people for increased tonnage resulted in the building up of a merchant marine that for size and speed, for energy and enterprise became, shortly, second to none but Britain, and in some aspects exceeded even that great sea power.

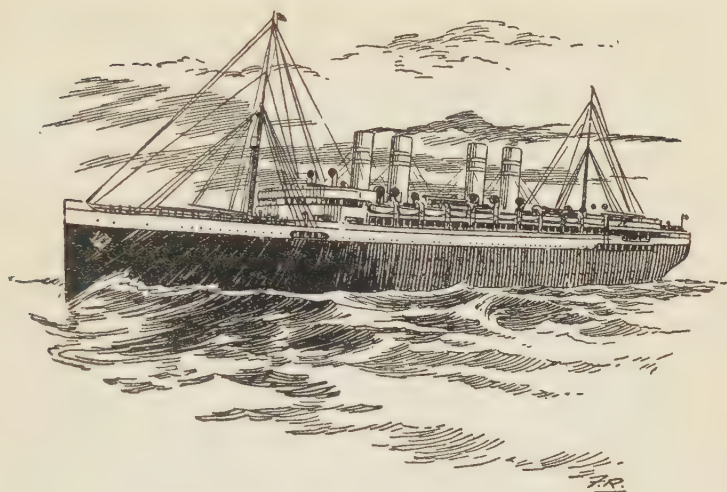
Britain, it is interesting to note, had built up a fleet of merchant ships that was predominantly composed of freight ships. Germany, on the other hand, built up a fleet dominated in numbers by her liners.

Of the dozen or so principal German lines that dominated her entire merchant marine, the Hamburg-American Line was the most important, and the North German Lloyd was second. At the outbreak of the World War the Hamburg-American Line made up about twenty per cent. of the entire German mercantile fleet, and totalled nearly five hundred ships of about eleven hundred thousand tons. This great organization in the sixty-seven years of its existence had become the most powerful steamship line in the world. Nor was the North German Lloyd far behind. In 1914 its tonnage had reached the huge total of 700,000.

These two lines, and eight or nine others, all of great size, controlled the great part of Germany's tonnage, and because of subsidies, of preferred rates given them by German railroads, of the practical control of German and Russian emigration, aided, or at least not opposed, by the Government, this huge fleet captured a very large percentage of the European emigrant travel and much of the world's fast freight. So vast was the Hamburg-American Line that their ships called regularly at literally hundreds of the world's principal ports and operated seventy-five separate services.

While the Hamburg-American Line was organized in 1847 and the North German Lloyd in 1857, their startling growth did not really begin until after the Franco-Prussian War, and even then for nearly twenty years their development was not surprising.

But in the twenty-four years following 1890 the German lines built fast and furiously. As late as the 'eighties they were buying British-built ships or were having their ships built in British yards, but then came the development of



THE DEUTSCHLAND

Formerly the holder of the transatlantic record.

German ship-building and before many years had passed greater and faster liners than any Britain had built came sliding from their German ways into German waters.

But Britain's claim to the mastery of the seas was not one based solely on her matchless fleet, and each time a German ship was built to outstrip the British flyers, a British yard was set to work on still a faster ship, with the result that despite the *Kaiser Wilhelm der Grosse*, the *Deutschland*, the *Kaiserin Auguste Victoria*, the *Kaiser Wilhelm II*, and many others, the British were able to answer with ships still faster until the *Lusitania* and *Mauretania* were built and the Germans called off their race for speed and started the building of such monster ships as have not yet been surpassed. The three greatest ships in the world to-day—the *Majestic*, the *Leviathan*, and the *Berengaria*—are all German built.

But Germany overreached herself and fell, carrying with her in her collapse all her ambitions upon the sea, for the

end of the World War saw her reduced to an inconsequential sea power—and reduced to such a state largely because of her illegitimate use of another kind of ship—the submarine.

While the race with Germany was at its height, however, Britain was never for a moment out of the running. The *Olympic*, the *Titanic*, the *Justicia*, the *Britannic*, the *Lusitania*, the *Mauretania*, and many others came from her ways. And although the *Titanic* ended her first voyage when she sank after a collision with an iceberg, and the *Justicia*, the *Britannic*, and the murdered *Lusitania* were casualties of the war, still Britain has giant ships, for the Germans, to pay partially for their submarine campaign, were forced to give over the most important section of their merchant fleet to the Allies, and Britain, properly enough, for her losses were far the greatest, rightfully secured the lion's share.

These giant ships, however, and their smaller sisters in the passenger trade are only a part of recent shipping developments. Once the compound engine had been perfected, steam, as I have said, began its competition with sail in the carrying of freight. Already the major portion of passenger travel had been taken over by steam, but until steam had become a more reliable and a less expensive power, sailing ships contended successfully for freight—particularly on long voyages.

In the 'eighties, however, or perhaps a little earlier, steam began its irresistible competition for freight and in thirty years sailing ships had come to play a small and comparatively unimportant part in the world's affairs. Still there remain many sailing ships, particularly in the fishing fleets and the coasting trade, and occasionally, but with less and less frequency, one sees a fine old square-rigged ship driving through the great green swells of mid-ocean, but they are few—and for the person who is drawn by the drama and adventure of the sea, painfully few.

In the 'sixties steamship tonnage was launched at about the same rate as sail in Great Britain, but early in the 'seventies the rapid increase of steamship tonnage began, and sailing ships correspondingly declined. Sailing ships were built, of course, and are still being built, and in Britain their average size even continued to increase until 1892, but then began to decrease in size to correspond with their decrease in numbers.

Steamships, on the other hand, increased both in individual size and in numbers. This increase in size had been noticeable ever since steam came to be a recognized source of power for ships. In 1815, for instance, steamships averaged only 80 tons. By 1830 this had grown to 102 tons; by 1860 it had risen to 473 tons; and its temporary maximum was attained in 1882 when the average had grown to 1,442 tons. The next few years saw a decrease, but 1890 saw the figure raised to 1,500 tons.

By that time steam had absolutely proved itself, and the day of the supremacy of the sailing ship on the high seas had definitely passed, and steamships had reached the point of almost infinite variety of design. So great and so diverse are the designs of present-day ships that Captain David W. Bone, in "The Lookoutman," published in 1923, expended the space of an entire volume to a discussion of them; nor did he enter into technicalities other than those that, at least to the sailor, lie on the surface. With this precedent to guide one I feel that I am perhaps unduly optimistic in endeavouring to cover this subject, even superficially, in the following two chapters; but so vast is the subject that this book pretends to cover that each chapter could easily be enlarged to many times its size.

CHAPTER V

THE PERFECTION OF STEAMSHIPS

MOST people who have had little experience with the sea, and many who have travelled on it, have little idea of the size of ships. Probably this is due to the fact that we see so much mention made of the world's greatest ships, with their tonnage and their other measurements, and so little of the thousands of ships that carry the bulk of the world's passengers and practically all of the world's freight. Our newspapers refer frequently to ships of thirty or forty or fifty thousand tons, but rarely do they mention the ship of 3,500 or 4,000 tons. Consequently, with such frequent mention of the giant liners before us, our tendency is, naturally enough, to imagine that they are typical of the sea, which is a very great error. In the transatlantic service there are only a very few steamships of more than twenty-five thousand tons. On other routes fewer still exist. It is as if we thought all buildings small because they do not equal in size St. Peter's in Rome, or Versailles in France, or the Woolworth Building in New York, for the greatest steamers are as much greater than the average as St. Peter's is larger than the little parish church, as Versailles is greater than the average home of a country gentleman, as the Woolworth Building is greater than the countless thousands of office buildings that house the great majority of business offices.

Yet these great ships, trifling in number though they are, are properly of interest to stay-at-homes and travellers alike, to landlubbers and sailors. The thing to remember, how-

ever, is that from the viewpoint of world commerce they are comparatively unimportant, and that the world could much more readily carry on its great affairs without these gigantic sea-borne palaces than without the smaller passenger ships and the countless thousands of "tramps" that roll and pitch and plod across the Seven Seas and make possible the commerce upon which the modern world depends.

It is important, therefore, to bear in mind what measurements constitute greatness in size, and what measurements are average. Such ships as the *Majestic*, the *Berengaria*, and the *Leviathan* are truly gigantic, and probably for many years to come they will not be greatly surpassed in size. So large are these three ships that they can enter only a few of the world's great harbours, they cannot be tied up at more



THE MAJESTIC

Formerly the German liner Bismarck. It is now the property of the White Star Line.

than a handful of piers, they cannot be docked at more than a few of the world's great dry docks. There are a few other liners that approach these great ships in size, but not many. The *Aquitania*, the *Bremen*, the *Mauretania*, the *Olympic*, the *Homeric*, the *Paris*, the *George Washington*, the *Belgenland*, the torpedoed *Lusitania* and *Justicia*, the *Titanic* which was wrecked on an iceberg—all these ships belong to the same race of giants, but there are few others, although, of course, there are other ships that bridge the gap between the wallowing tramps and these that I have mentioned.

For the present, however, I shall pass by the smaller ships, more important though they are, as a race, and describe, in some detail the marvellous ships that voyage between the English Channel on the East and New York on the West, for it is in this service that all the greatest ships are to be found.

Modern marine engineering is quite up to designing, constructing, and operating ships greater than any that now exist, but should much larger ships be built little would be gained. New dry docks would have to be built, new piers constructed, deeper channels dredged, all at huge expense, and the building of such ships would in itself call for disbursements so vast that the companies operating them would find it difficult or perhaps impossible to make them pay. Consequently, I shall content myself with describing what now exists, feeling certain that any developments within many years will not so much surpass these great ships already afloat as to make my remarks entirely out of date.

As an example, therefore, let us take the *Majestic*, which, despite some argument on the part of those who put the *Leviathan* in commission, is slightly larger than any of the others I have named.

To say that she is 956 feet long and 100 feet broad means

little. It may, perhaps, mean more to say that it would not be advisable to anchor more than four such ships in a harbour a mile square and forty-five feet deep. But even that, perhaps, may leave one wondering.

An automobile can turn around without difficulty in a street fifty feet wide. If the *Majestic*, however, found it



THE LEVIATHAN

Formerly the German liner Vaterland, and taken over by the United States during the World War.

necessary to turn around while under way without resorting to anything more than the use of her steering wheel she would require a channel more than a mile wide. In a much more restricted space than that, the utmost skill in reversing her propellers or the use of tugboats would be essential.

It is trite to remark that such a ship is a floating city, yet she actually is. Her passengers and crew together, at the height of the tourist season, number more than 5,000, but no town in the world of that population has such luxuries

or comforts, such machinery or such artistic interiors as this great ship carries as its equipment.

In order to give an adequate idea of what this vast steel structure contains and is propelled by it will be necessary to divide it into two major parts—that is, the hull and the machinery, and the accommodations for passengers.

First let us take the hull and the machinery.

The hull of a ship is its prime necessity. Without a hull there can be no ship, just as without a foundation and without walls there can be no house, for a ship's hull combines her foundation and her walls. In order, then, to understand the greatness of the gigantic liners we are discussing the first thing to understand is the hull.

All hulls of great size are built of steel. First a great steel framework is constructed, then it is covered with sheets of steel and many steel decks are built, and steel bulkheads are installed in order to give still greater strength.

In building such a ship the first thing necessary is a great yard large enough to accommodate the ship, and many shops in which parts of the ship are to be made or assembled. There is an incline constructed on which the ship will be built, and the incline is so arranged as to slant down to the water's edge. The ship's frame is first put up, and the first part of the frame is the keel. The keel is a long and very heavy backbone that runs the entire length of the ship and is the centre of the bottom. To the ends of this are fastened the great steel frames that rise high above the keel to form the bow and the stern—that is, the front and back of the ship. At narrow intervals between these two towering ends are erected the "frames" or ribs, which, in order to make them strong, are built up like great steel girders, running from the keel along the bottom and up the sides. When all of these are riveted in place a very good idea of the shape of the ship can be secured. Amidships—that is,



THE BREMEN

This German liner took the transatlantic record from the Mauretania.

halfway from the bow to the stern—these frames are very much like a broad and flat-bottomed U, but as they approach the bow they are more and more like huge Vs. Toward the stern they take more unusual shapes, somewhat like a V except that a little above the bottom on each side they curve sharply out and back in a semi-circle in order to go around the shafts on which the propellers are carried.

Thousands of men work on these huge steel structures, and a “skin” of steel is riveted on the outside of these frames. In the bottom and extending a little way up the sides a second “skin” is placed on the inside of the ribs. These two coverings make up the “double bottom.”

Girders for decks are put in place, great rooms are left for boilers, engines, and other equipment, the shafts are installed, the engines and boilers are bolted in place, and finally, when the ship is getting fairly well along toward completion, she is launched. That is, the great timbers

that have been holding her in place are sawed in two, and the great vessel slides down the ways into the water.

After she is launched the infinite number of tasks still untouched are attended to, and finally she is completed—a marvellously complicated and wonderfully perfect fabrication, into which almost every industry in a nation has put something.

These hulls are huge and are tremendously strong, yet so great are the dimensions of the ship, so great her weight, that should her giant hull touch a rock the heavy steel plates would curl up like paper, the frames would bend like tin, and driven head on against a cliff or an iceberg the great structure would crumple its bow, twist its great frames, and might become a total wreck.

Modern ships that are propelled by machinery use two principal methods of propulsion, paddle-wheels and screw propellers. Paddle-wheels bear a very close resemblance to mill-wheels. They are merely great circular structures with paddles attached at intervals around the circumference which, when the wheel is partly submerged and set to turning, strike the water one after the other and so propel the hull to which the wheel is attached. These wheels are sometimes arranged amidships, one on each side, and sometimes but one wheel is used (in this case it is much broader) at the stern, or rear end of the vessel. This equipment is not satisfactory for ocean-going ships, for heavy seas sometimes crush the paddle-wheels. River steamers, however, and particularly shallow-draft river steamers, find this means of propulsion satisfactory.

The other method of propelling ships—that is, by screw propellers—is more important, and for use at sea is practically universal.

A screw propeller operates on exactly the same principle as an electric fan, and ships may have one or more of these

propellers, which are fastened to shafts projecting through the hull beneath the water at the stern. If the ship were tied up strongly to a pier, so that it could not move, and the propellers were turned by the engines, the result would be to set in motion a column of water away from the propeller just as an electric fan sets in motion a column of air. The resistance of the water is so great, however, that once the lines that secured the ship to the pier were thrown off, the propellers would set the ship in motion, and the propellers would progress through the water in somewhat the same way that an ordinary wood screw advances through wood when a screwdriver is properly applied.

The *Majestic* is propelled by four of these propellers, two on each side astern. Turning at 180 revolutions a minute they utilize 80,000 horse power. One might think that propellers would waste much of this power—that is, that they might turn in the water without pushing the ship forward very much, as a wood screw sometimes turns round and round without getting a grip on the wood into which the carpenter wishes to drive it. This is true to some extent when a ship is first starting, but once the ship is in motion a properly designed propeller will be 95 per cent. efficient—that is, it will go as far in 100 revolutions as if it ran without any “slip” for 95 revolutions.

A propeller is measured by its diameter, just as an electric fan is measured. A propeller ten feet in diameter is one whose blades, measured from the centre of the shaft, are five feet long. Another and equally important measurement is the “pitch”—that is, the distance forward the propeller would travel in one revolution if it were running through a solid. Take a wood screw and look at it carefully. You will find that the threads run around it in a spiral. Mark a spot on one thread, and then trace the thread around the screw until it again reaches the side you marked. It will

have advanced toward the point, and the direct distance between the place you first marked and the place you have arrived at would be the "pitch." As a propeller blade travels in a path similar to the thread of a screw, its pitch is similarly measured.

The four propellers on the *Majestic* are built of manganese bronze and each carries four blades. They are $16\frac{1}{2}$ feet in diameter, and their pitch is 14 feet $11\frac{1}{2}$ inches.

Two of these propellers turn one way and the two on the opposite side turn the other. This is to offset the tendency to swing the ship out of its line of travel, which would be very apparent if all the propellers turned one way. Ships with one propeller feel this action very plainly.

Such huge propellers as the *Majestic* carries, and such great power as her engines develop, necessitate the use of heavy shafts, which are the great round steel rods that connect the engines and the propellers. These shafts run from the centres of the propellers through the ship's stern to the engine room, and in the *Majestic* are $16\frac{1}{2}$ inches in diameter. Where they enter the ship there must be a very carefully built "stuffing box" and bearing which will prevent the entrance of water. Once each shaft has passed this bearing it runs for a considerable distance through a "shaft tunnel," which is a long, low, narrow compartment through which men may walk in order to inspect the shaft and see that the bearings, which are spaced at intervals along the "tunnel," are properly oiled. Finally the shaft reaches an apparatus called the "thrust block." This is a simple but highly important arrangement. To explain its use it is necessary to go back to the propeller.

When the engines are in motion and the propellers are being turned they develop a great "push" against the water, and it is this push that makes the ship move. If, however, something were not done to take up the push, the propellers

would slide the shafts lengthwise through their bearings, and the end of the shaft attached to the engine would press so hard against it that it would push the engine from its base, or at least would wear the bearings out, and the engine would be damaged.

In order to receive this "thrust," as it is called, the "thrust blocks" are installed. There are several designs, but they all accomplish the same task in a similar fashion.

The shaft is equipped with a series of "collars." These collars, which are enlargements of the shaft, are so placed that they fit between a series of surfaces attached firmly to a heavy fixed base, and when the propeller thrust tends to slide the shaft lengthwise, the "collars" press against these



THE MAURETANIA
A British liner of the Cunard Line.

interposed plates which prevent the shaft from moving laterally without preventing its rotation. Naturally enough these thrust blocks must be lavishly oiled, for the friction between the turning collars and the fixed thrust blocks would otherwise soon wear both the collars and the blocks. When the propeller is reversed the thrust is against the other side of the collars, and so the engine is relieved of all duties save those of turning the shaft.

When the shafts have passed these thrust blocks they have entered the engine room, which on these great liners is a place far different from the engine rooms on the smaller ships that are to be found the world over.

Perhaps the first thing that would strike an inexperienced visitor in the engine rooms—for there are three—of the *Majestic* is their size and the absence of moving parts. Aside from the hum of turbines and generators and the vibrations that are a part of every power plant, there is little to tell a person unacquainted with such power installations that the engines are going. Great turbine cases are bolted strongly to their bases, but the rapidly moving vanes are entirely hidden from view. A few men wander here and there, some watching indicators, others testing bearings, still others polishing the already shining machinery, but there are no turning shafts, no moving wheels in view. As a matter of fact, most of the visible motion and most of the sounds as well come from a lot of little machines whose duties are important, of course, but are not directly connected with that one great task of spinning the propellers at 180 revolutions every minute day and night while the miles are being rapidly put behind the great ship as she speeds along her route across the Atlantic.

So complicated and so huge is this collection of machinery that it may, perhaps, be better to pass by the engine rooms for the moment and go to the stokehold, or boiler room, in

order to get an adequate idea of how the machinery is operated.

In smaller ships all the boilers can often be placed so that there will be but one stokehold—that is, one compartment from which all the boilers are fed. Ships of the size of the *Majestic* and *Leviathan*, however, are equipped with so many



THE BELGENLAND
Belonging to the Red Star Line.

boilers that they cannot all be grouped about one stokehold. The *Majestic*, for instance, has forty-eight separate boilers which, if they burned coal, would require 12 chief stokers, 197 firemen, and 168 coal passers in order to keep the fires burning properly. The most modern of these giant ships, however, do not burn coal. Oil is led to the boilers in pipes and, on the *Majestic*, but eighty-four men are required to get the results that it would take 377 men to get with coal. These 84 men are divided into three watches, so that the

fires are kept burning and the steam is generated with but 16 fire-room attendants and 12 cleaners at any one time. They work for four hours, and are then off eight, coming to the fire room every twelve hours for their four-hour watch.

Each of these boilers has five burners, to which the oil is forced under pressure. Each fire-room attendant (they can hardly be called stokers) has three boilers, or fifteen burners, and the steam pressure in the boilers can be carried at 240 pounds pressure per square inch.

In ships burning coal the stokehold is a grimy place, with yawning openings in the sides leading to the black bunkers where the coal is stored. A few dust-covered electric lights glow dimly in the murky dusk, and when a furnace door is opened the glare of the fiercely burning fires lights up the begrimed and sweating stokers, who seem almost like unearthly creatures toiling in an over-heated Inferno.

But the great oil-burning liners have a different picture to present. The fire room is almost as neat and clean as is the engine room. The firemen do not seem to be over-worked, as they step from one to another of their burners, looking through a series of peepholes to see that the oil is burning properly. Smudges of dirt are not uncommon on a man's face and hands, perhaps, but the begrimed Vulcans of the coal-burning ships have no counterpart on the oil burners, and the coal dust and the dingy stokehold is a far cry.

The *Majestic's* boilers do not depend upon natural draft, but a set of four powerful fans draws the warm air from the turbine rooms through two great air shafts about seven feet in diameter and forces it under pressure beneath the boilers. These great air shafts total 1,000 feet in length, and a part of the air they supply is led to each boiler. In addition to this supply for the furnaces there is a separate supply of fresh air for the crew of the boiler rooms. The boilers are all separate and

any one or any series can be completely shut off from the others in case of necessity.

The steam that is generated in the forty-eight boilers of the *Majestic* is led by a complicated system of pipes to the turbines, which drive the propellers.

Formerly steamships universally used the reciprocating engine, but gradually the turbine is being adopted, until now the fastest ships are universally equipped with this later design.

A reciprocating engine is one that has one or more cylinders in which pistons are pushed back and forth by the steam which enters alternately one end of the cylinder and then the other, thus turning the shaft. This piston, running first up and then down, is joined to a "connecting rod" which in turn is connected to a "crank shaft" which is a continuation of the propeller shaft. As the piston moves up and down, one end of the connecting rod moves with it, for it is fastened by a hinge to the lower end of the piston rod which runs out of the bottom of the cylinder. The other end of the connecting rod is attached to the crank shaft which has a section of itself carried out to one side just as the shaft on which a grindstone is mounted is bent at right angles and attached to the handle. As the piston goes up, carrying the connecting rod with it, the off-centre section of the crank shaft is carried up also, as the handle of a grindstone is carried up when the operator begins to turn the wheel. When the piston has reached the top of its stroke the connecting rod has pulled the crank until it is pointing straight up. Then the steam pushes the piston down and the piston pushes the connecting rod, which in turn pushes the crank, so that the shaft is turned, just as you might turn a grindstone by hand, your arm representing the piston rod and connecting rod, and the handle representing the crank shaft.

The turbine, however, is a very different machine. There

are no pistons and no other parts similar to those of the reciprocating engine. Instead there is a shaft on which is mounted a great steel wheel. Around the edge of this wheel are mounted thousands of little vanes, and the whole wheel works on the same principle as a windmill. A windmill carries a comparatively small number of vanes arranged somewhat as the blades of an electric fan or a propeller are arranged. When the wind blows against these "vanes" the wheel revolves. Now a turbine is a very highly developed example of this same principle, and the steam is led to it through pipes and directed against these vanes, which are small but are very numerous. The result is that this windmill type of engine revolves at a very rapid rate. One can get some idea of these turbines when he learns that the eight turbines of the *Majestic* contain a total of 900,000 vanes.

Turbines, however, have two major failings: First, they cannot be reversed—that is, a turbine can turn in only one direction—and second, they are most efficient when they operate at high speed. In order to use turbines on ships, then, it is necessary to have one turbine on each propeller shaft to drive the propeller ahead, and another turbine with which to drive it astern. Consequently, the *Majestic* has eight turbines—two to each propeller shaft.

The second difficulty is harder to overcome. Propellers are most efficient when they are run at comparatively slow speeds. Those on the *Majestic* are no exceptions to this rule, and at full speed are run at about one hundred eighty revolutions per minute. Turbines, however, are high-speed machines, capable generally of thousands of revolutions per minute. In order to utilize the power generated by the rapidly revolving turbine and transpose it into useful energy for use by the slowly turning propeller there must be some sort of reduction gear. The United States Navy has de-



THE GEORGE WASHINGTON

An American liner, formerly a German ship. She was taken over by the United States during the World War.

signed a number of its newest ships with an electric drive in which the high-speed turbines are used to generate electricity which is used to turn slow motors that drive the propellers. Another method is a reducing gear, similar in the work it does to the gears used in automobiles for "low" and "intermediate," but necessarily very much greater in size. In the *Majestic* the arrangement is of the latter type—that is, the turbines are operated at high speeds, and through a series of gears the propeller shafts are turned at slower speeds.

Necessarily, in operating ships of such size as these we are discussing, any wasteful methods would be very expensive. It is open to some question as to whether these huge ships are worth what they cost, for the margin of profit they show is very small, and the cost of operation and repair is huge.

In order, therefore, to make them pay it is vitally necessary to eliminate waste. For instance, if the turbines were each operated by steam direct from the boilers, and this steam were sent direct to the condensers after having passed only once across the vanes of a turbine, it would take very nearly four times as much steam, and four times as much fuel, to operate the *Majestic* as it does with the system that is installed. Only part of the power of the steam is used up in the first turbine through which it passes, so when the ship is at full speed, the steam, still under comparatively high pressure, although much less than when it left the boilers, is led from the first turbine, which is called the high-pressure turbine, to a second turbine, called the intermediate. Here again it fans the vanes and the turbine revolves, but once more the steam is used, for part of its power still remains. This time, however, the pressure is much less, and the steam has expanded until it takes up more space than it took up in the boiler, just as the air in the rubber bladder of a football would take up more room if the leather cover which keeps it compressed were removed, or the inner tube of an automobile tire would expand if the "shoe" or "casing" were not around it. This expanded steam is divided, when it comes from the intermediate turbine, and is led to the two outside turbines—that is, the turbines that operate the port, or left hand, and the starboard, or right-hand, propellers. These are the low-pressure turbines, and when the steam has passed through these turbines, causing them to turn, its work is done and it is led to the condenser.

Condensers are a vital part of every sea-going steamship's equipment. Locomotives do not need them, and stationary engines ashore do not, for they can easily replenish their supply of water, but to a ship crossing the ocean, fresh water is a vital necessity, for its boilers no less than for its passengers and crew, and should the used steam be allowed to escape,

the ship, no matter how great her water tanks might be, would probably run out of fresh water long before her voyage could be completed, if it happened to be at all long. If, in such a predicament, she should attempt to use salt water there would very soon be a heavy covering of salt inside her boilers and her steaming ability would become limited, and, furthermore, the boilers would very shortly require a thorough cleaning.

In order to prevent this difficulty from arising, all salt-water steamships and many that are used on fresh water, for lakes and rivers often contain sediment that would foul the boilers, use condensers. These are water-cooled systems of pipes through which the steam is led after its final release from the engines. The steam, which of course is still hot, is led through these carefully cooled pipes, and in coming into contact with the cool walls of the pipes is condensed, just as the moisture in your warm breath is condensed in the winter when you breathe against a cold window pane. This condensation turns the steam into water once more, and it is led back to the tanks where it is held in readiness to be sent again to the boilers.

The auxiliary machinery of such a ship as the *Majestic* or the *Leviathan* is even more complicated than, although not so powerful as, the engines which drive the propellers.

I have mentioned the ventilation system of the stokehold, but that is only a small part of the system that ventilates every nook and cranny in the whole huge structure. There are refrigerators, which are capable of keeping in cold storage large quantities of perishable products. There is even, on the *Majestic*, a second refrigerating plant intended to cool a cargo hold in order that perishable freight may be carried. Another important auxiliary machine on the *Majestic* is a Diesel engine for generating electricity in case something might put the main generating plant out of commission.

With this emergency plant, power is assured for lighting and for lowering the lifeboats.

In order to handle so great a ship when the engines are necessarily at such a distance from the "bridge" where the officer in command has his post when the ship is under way, it is necessary to have some means of communication between the bridge and the engine room.

A person driving an automobile is not only in command of the steering of the machine, but is also in direct charge of the engine, the gears, and the brakes. Not so the captain of a ship. Neither he, nor any of the men with him on the bridge, has any means of starting or stopping the engines. There is a man at the steering wheel, of course, but the men who start and stop and reverse the engines are far below the bridge and far aft, hidden away beyond where any shouted orders could possibly reach them. Yet the engines must be operated as the captain commands, for he is the man who can see what must be done—he is the one upon whose judgment the safety of the ship depends.

In order to bridge the gap between the bridge and the engine room an apparatus called the "engine-room telegraph" has been perfected. There are a number of designs, but all of them by simple mechanical means permit the officer on the bridge to operate a handle and set a hand on a dial placed in the engine room so that it signifies the officer's orders.

All this that I have so far described, and much more that I have not even hinted at, is put into a ship merely in order that passengers and freight can be quickly and safely carried over the sea. In these days of luxury, however, passengers demand more than speed and safety. Comfort is, from the viewpoint of steamship lines vying with each other for passengers, a vital necessity, and competition has added comfort to comfort until ships have become lavish and

luxurious, and such service as can be had only at the finest hotels and watering places ashore are commonplaces of the sea. Every luxury that lies within the bounds of reason—and, to be truthful, a few that seem to lie just across the border—are to be found on the greatest ships of to-day. Does one wish a suite of rooms with private parlours and solariums, numerous bedrooms and private baths? It is to be had (by the payment of a price) and one is king of truly regal quarters for a passage. Does one wish to bathe in such a bath as Caracalla would have marvelled at? One has merely to go below, put on a bathing suit in the privacy of a perfectly appointed dressing room, and plunge into the crystal water of a pool that would have been the envy of any luxury-loving Roman—a pool so great that in it the smallest of Columbus's ships could comfortably ride at anchor. Does one wish to entertain one's friends at dinner? A word to the steward, and when the party is led to its table, there it finds all the brilliance of snowy napery and polished silver, of sparkling crystal and fragrant flowers,



THE HOMERIC

A British liner belonging to the White Star Line.

with specially printed menus prepared for the event. Has one "snapped" some scenes about the deck with his camera? He has merely to take the film to the dark room and develop it himself or have the task performed by an attendant. A doctor is on duty. An orchestra is carried in order that music may be had for dances, for entertainments, and during meals. A library, with great thick rugs, with easy chairs, and cases filled with books beckons to one when other pastimes pall. A smoking room where card games can be played is a popular centre. A palm garden and an à la carte restaurant are to be found in addition to the regular dining room. A gymnasium is convenient. A nursery for small children is available. But a complete description of such a ship is all but impossible.

These are the ships that are the perfection of the type that have all but driven sails from the seas—that have, in the carrying of passengers, entirely eliminated sails. Yet hardly had they reached the point where they might comfortably settle down to profit from the elimination of their ancient rivals, when an upstart ship—a ship whose lineage is so limited that its entire development lies in the 20th Century—put in its appearance and already has gained such a foothold among steam-driven vessels that it seems not unlikely that the days of steam upon the sea are numbered.

These new vessels are the motor ships. In fifteen years they grew from experimental craft to great and powerful liners capable of holding their own against all comers. The *Aorangi*, a great liner of 23,000 tons displacement, now operating on the Pacific, and hundreds of other motor ships of scores of types point dramatically to the end of the era of steam.

CHAPTER VI

STEAMSHIPS OF MANY TYPES

OF THE super-giant ships there are, as I have said, very few, but as one starts looking for smaller ships, he finds them much more numerous. Under the British flag alone there are about two hundred ships of ten thousand or more tons. In the entire world there are about twenty-nine thousand steamships of five hundred tons or more.

It is this enormous fleet to which we now must turn in order that we may continue our ever-widening story of the development of ships. And with this vast fleet we shall include the countless thousands of still smaller steamers that serve as many thousand masters in a great diversity of ways. The ships to which I shall refer in this chapter are so diverse in size, in duties, and in model that it almost seems that the only thing they have in common is their universal ability to float on the surface of the water.

First there are the mail liners, which differ in few things other than size from the huge vessels I have described in Chapter V. And even in size they are more or less comparable, as they are from twelve or fifteen thousand tons to twenty-five thousand. As a class they are hardly less luxurious than their greater sisters, and their speed is only slightly less. And aside from these two things there is no essential difference, except that they are more numerous and are less expensive to build and to operate. And, too, they are less expensive to travel on, which is a blessing for those of us who cannot afford to pay the rates of the giant liners.

But other differences are few, and a description of the super-liners is, in all details save those I have just mentioned, a description of these other ships which travel most of the main ocean lanes, and girdle the earth with comfortable travel routes. They cross the North Atlantic between Europe and America. They cross diagonally from the Old World to the wonder cities of Rio de Janeiro, Montevideo, and Buenos Ayres. They journey through Suez on their trips to the Far East and return. They link China and Japan with the United States and Canada, and regularly sail from North America to South. For all their comparatively limited numbers these ships visit many of the world's important ports, for they are busy—very busy—and one never sees them laid up when business is slack, nor do they idle about port for lengthy stays. Every minute that is possible they are on their way across the oceans, and a year or more ahead their sailing dates are scheduled. These are the ships that sail the great sea lanes almost as regularly as the great express trains pass along their tracks. And these are the ships that visit the most important ports of earth. But important though they are, we can give them no more time. Already we have told about their greater counterparts and, too, have said that there are no vital differences save size.

But dropping down the scale of size, which is the only yardstick that is ready at hand by which to classify these ships, we come to a more numerous category. Captain Bone, in "The Lookoutman," lists these as "intermediate liners." I have vainly endeavoured to find a better way to list them, but I always come back to his method, and so, I suppose, must use it.

The intermediate liners, ranging, perhaps, from five thousand tons to twelve or even fifteen, are of many types and are engaged in the performance of many tasks. They visit

the lesser ports and the greater with a fine disregard for anything save the business on which they are engaged. You will find them stopping at Capetown on their way to Australia from Liverpool. You will find them at Central American ports loading bananas. They visit Guayaquil, Havana, Piræus, and Sydney, and lord it over the smaller



A MAIL LINER

These ships, while somewhat smaller than the biggest ships and not quite so fast, are perhaps the most popular of passenger ships, for their rates are not so high as those of the great ships, and their accommodations are more or less comparable.

craft that fill those busy harbours. They fill a less pretentious place in Liverpool and New York, and now and then they drop their anchors in tiny mid-pacific ports, or manage, with difficulty, to get behind the breakwaters at Ponta Delgada, or churn the tropic water at Mombasa, or anchor at Christchurch.

Some of them are dowdy and old and keep themselves

respectable only by many applications of paint, as a man who has seen better circumstances will often keep his ancient suit from appearing too unpresentable by the frequent application of the whisk broom and the pressing iron. But others of these ships are sparkling in bright woodwork and have the smoothest of unscarred sides. Their decks are holystoned to the whiteness of a Dutch matron's kitchen table, and their passenger accommodations are beyond criticism.

But the passenger space on these ships is generally somewhat limited, although many of them are most elaborately equipped, and the holds are for ever being emptied or filled with the kinds of freight that require rapid shipment, or, coming in small parcels, can afford to pay the higher rates these ships demand.

They sail on scheduled dates and have routes of their own, which often include more or less numerous ports of call, and they all belong to steamship lines of major or minor importance which maintain offices or representatives at most of the ports that give them their business. The United Fruit Company, the ships of which traverse the Caribbean, and call at Havana and other major ports in addition to many small ones on their voyages from and to New York, maintains great banana plantations, which furnish the larger portion of the freight these beautiful white ships carry. Other lines have other interests, some maintaining a rigid aloofness from interests farther from their ships than the passengers and freight of the ports at which they call. But these ships take one comfortably to many such out-of-the-way places as would hardly seem worthy of their attention.

Again, however, the fundamental differences, save size, between these and the great liners are comparatively slight. In size, it is true, the difference is vast. It would take a round dozen of the smaller intermediate liners to equal in



AN AMERICAN INTERMEDIATE LINER

Ships of this type were developed during the World War.

bulk the great *Majestic*. And still these ships are not to be called small. They may, perhaps, be four or five hundred feet in length. Their speed, it is true, is likely to be far less than that of the great ships, for they make, perhaps, fifteen or sixteen or eighteen knots, while the great ships may reel off twenty-five or more an hour.

Still, their likenesses, at least superficially, are greater than their differences. There is likely to be a difference in the number of funnels and masts. Derricks are probably more numerous on the smaller ships, for they carry more cargo, strange as that may seem, than the great ships. The intermediate liner has fewer decks, but that would seem at first glance to be because the proportions of the ship are such that numerous decks are impossible. The real reason, however, is that the cabin accommodations are limited.

But a passenger on the intermediate liners will probably be very nearly as comfortable as a passenger on the greatest of ships, although he won't find a Pompeian bath, or a Palm Garden, or any of those super-elegant appurtenances that are common on the greatest ships. But for pleasurable travel these ships—or at least the better of these ships—are often preferred by experienced travellers, for simple surroundings are to many people more pleasant than gorgeous elegance.

“Cargo liners,” again using Captain Bone's classification, are of a different type. Their sizes are hardly subject to definite restrictions, for, granted that a ship belongs to a shipping line and sails on scheduled dates between two or more ports and carries such freight as may be brought to her, she is a “cargo liner,” whether she be of five hundred or of fifteen thousand tons. In practice, however, these ships range, perhaps, from five to fifteen thousand tons, and as they supplement, to some extent, the freight-carrying passenger ships of the lines to which they belong, their speed is high, for freighters. They make, perhaps, fourteen or fifteen or even sixteen knots an hour, and they are likely to be fine, wholesome-looking ships, handsome in their lines and proud in their appearance. And for this they have some reason, for they are the queens of the cargo fleets, and steam proudly past the dowdy tramps just as the giant liners and the mail liners sweep past the intermediate liners.

But now we come to what seems to me to be a more romantic class—the tramp steamers—for they are of the rank and file—as the farmer and the workman in our factories are of the rank and file. Kings and presidents, members of Parliament and of Congress are for ever in the papers, while the simple folk who give these people the exalted positions they hold seldom see their names in print. And likewise the great liners and, to a lesser degree, the mail and intermediate and cargo liners, are often in the public print,

while the tramp steamers, which make possible the conditions that have brought the others into being, are seldom written of. For, from the point of view of the world's work, these simple ships are mostly vitally important to it, just as the "common people" are of more value to a country than are the holders of high office.

And as one finds great differences among a country's "common people" so does one find great differences among these "common people" of the sea, upon whose sturdiness and brawn and energy depends that vast web of commerce without which the modern world, as we know it, could not exist.

There is hardly a single important thing that is common to all these ships. True, the possession of but one funnel seems to be an all but universal attribute, but aside from



A CARGO LINER

A cargo liner is a freight ship that sails on scheduled dates and routes, and is different in this from a "tramp" which takes what cargoes it can at any time and to any port.

that the streaks of rust that mar their dingy sides are almost the only marks they all possess. Sometimes one sees a smartly painted tramp, it is true, and she presents a pleasant sight, but paint is not tough enough long to stand the wear and tear of this service, and coat after coat is scratched by piers or heavy freight, or peels beneath the blistering tropic sun, or is stained by chemicals or strange cargoes from outlandish ports. And even the most careful captain cannot prevent the rusty-looking spots, for red lead paint must first be applied to the denuded steel, ere it is covered with the more seemly black, and while one spot is being made more reputable, another is fast losing its thin armour of paint, so that rust or red lead seem always to be in evidence.

But all of this is merely superficial, and appearances, in ships as in people, often grossly deceive

It is perhaps unfortunate that these hard-working ships should ever have been called "tramps," for the word suggests a lack of respectable employment to people ashore, as well as a wandering spirit. Among people ashore a tramp is looked down upon because he is content with hardly more than enough to eat. He produces nothing. He works at nothing. His irresponsibility is ever uppermost, and he is sure to do but one single thing—to keep for ever on the move. But at sea a tramp is a ship that works most diligently. She journeys, it is true, on no set route, and never knows—or seldom—for what port she is likely next to steer. But she works! Every possible moment of her workaday life she works. From the day she has passed her builders' tests and is turned over to her owners she labours as no man or no man's beasts of burden were ever worked. Day and night she sails the lonely seas—from Liverpool to Shanghai—from Shanghai to Capetown—from Capetown to Sydney—from Sydney to New York—from New York, perhaps, to Liverpool again—but not for rest. She may, it is true, be

docked and repaired, but once afloat again, and noisy, dirty streams of dusty coal pour chokingly into her cavernous holds, and off she goes again, perhaps to Spain, where her coal may be exchanged for a cargo of iron ore, and back she sails, to discharge and load again and sail, until, at last, when years have passed, she has outgrown her usefulness and is



A TRAMP STEAMER

Perhaps the hardest-working machine ever designed by man, and undoubtedly the most romantic of all steam-driven ships.

flung upon a scrap heap where everything of value is taken from her hulk and she is forgotten—as workmen sometimes are, who through all their lives have laboured, day after day, at forge or bench, making for the world some of the many things it needs, only to find themselves, when they are worn out, forgotten and replaced by a man more new.

These are the ships that make world commerce possible. These are the ships that carry the world's goods. These are the ships that make a nation's merchant marine, and

these, basically, are the ships that make necessary great navies and great ports. Here, then, lies the modern romance of the sea.

The most common type of tramp steamer has a raised section amidships, where are placed the bridge, the funnel, and a group of houses containing the galley (which is the kitchen of a ship), staterooms for her officers, and, perhaps, a messroom. Below this lie the boiler and engine rooms. Forward of the bridge the deck drops six or eight feet to a lower level, and as it nears the bow, it is raised again to a little above the altitude of the midship deck. This is still called the forecastle, after those weird structures raised at the bows of ships in the Middle Ages. Aft the midship section the deck drops away as it does forward, and at the stern is raised again, until the stern is about level with the midship deck. Long since, however, the name sterncastle has been dropped. This section is the "poop."

Sometimes light bridge-like runways are raised above the lower parts of the deck forward and aft of the midship section, connecting the bow and stern with the group of deck houses amidships, for when the cargo has been stowed these ships are deep in the water, and these low decks are but a little way above the surface. Once they are at sea, at least in heavy weather, "lippers," or waves that reach their crests just over the low bulwarks, seem for ever to be flooding these sections of the ship. And once a storm blows up, these decks are often buried beneath tons of solid water, and the crew, housed forward in the forecastle, and the captain, who sometimes lives astern, would, without the raised runway, be more or less marooned and helpless on board the very ship they are supposed to operate.

So diverse in design, in operation, and in equipment are these ships that it is impossible to describe them as a unit. Their tonnage ranges from a few hundred to ten thousand.

Their crews range from fifteen, perhaps, to fifty. Their engines may be reciprocating or turbine. It is usual, however, for them to have but one propeller, and their speed is low. Seldom do they make less than eight knots an hour, and seldom, too, are they able to make as much as fifteen. Some are well equipped with useful auxiliary machinery for doing much of the heavy work. Others have hardly more than a few steam winches installed to aid in loading and discharging their strange variety of cargoes.

A ship may sail from Newport News to Havana with coal, and while she is discharging at her berth may receive orders to proceed to Caibarien for a cargo of sugar. She grunts and shrieks and groans as the Havana stevedores take the coal ashore, her crew more or less idle, except for odd jobs, for crews of tramps attend to neither the discharging of cargoes nor the loading. Once the coal is ashore, however, the crew has a job. The ship must be fumigated, by order of the port authorities, and once fumigated the hatches must be lifted off, and the vast caverns into which the new cargo is to go must be swept and cleaned with care, for sugar does not mix too well with coal dust. And then the ship is off down the Cuban coast, riding high out of water, her propeller blades splashing half in and half out. If the weather is pleasant the holds may be cleaned on the way, and once she arrives off Cay Frances—for she cannot enter the shallow harbour of Caibarien—her captain orders the motor boat over the side, if he has one, and journeys a dozen miles to the little port. Here he tries to hurry the cargo lighters out to his anchorage, for it costs money to keep a ship idle. She is paying dividends only when she is on her way from port to port, and it is one of a captain's important duties to do everything he can to get her on her way again. If his company has an agent at Caibarien, which is unlikely, the agent, too, tries to speed matters, but Cuban ways tend to slowness, and it is likely

to be a day or two before a couple of barges are brought alongside, with a gang of Negro stevedores who slowly commence their operations. The derricks are rigged beside each hatch and the great bags come aboard in sixes or eights and are dropped into what seem to be the bottomless pits below the yawning openings. Far below, another group of stevedores cast the tackle off, and one by one the bags are packed, so as to fill the hold to the exclusion of a cubic inch of space not utilized. All day they load, and all night, for as one barge is emptied another appears. Relief crews of stevedores appear, and under a cluster of lights hanging from bridge or mast they labour—their toil seemingly endless, but gradually, nevertheless, approaching its conclusion. Lower and lower the ship sinks into the water. Her propeller blades disappear, and down and down she goes. No longer is she the wall-sided affair that anchored a day or two before. And finally, as the bags reach up and up to the combings of the hatch, she is down once more, until her Plimsoll mark, which is cut in her side by Lloyd's to show how deep she is permitted to ride, is washed by every wave. A few more bags—the last big barge is empty—the last bit of space in her great holds is filled and she is ready for her voyage to Brooklyn.

Once more the crew becomes active. Girders are lowered into their places across the twenty-foot-wide hatches. Great planks cover the opening, and several huge tarpaulins are unrolled and spread above the planks, for cargoes must be guarded against salt water. These coverings are carefully put in place while the stokers raise the boiler pressure once more, and ere the last of the preparations is completed another voyage has been begun.

There are many other types of ships that busy themselves about the sea. One of these is the oil tanker, a ship built



AN OIL TANKER

These ships have come to the seas in very recent years. They are used only for the transportation of oil, and are owned largely by the great oil companies.

for but a single purpose. These are owned by the big oil companies whose products come from Mexico or the Dutch East Indies, or, originating in the United States, are sold to countries not so fortunate as to have oil wells of their own.

An oil tanker has an appearance more or less its own, although the great carriers of ore and grain on the Great Lakes are very similar.

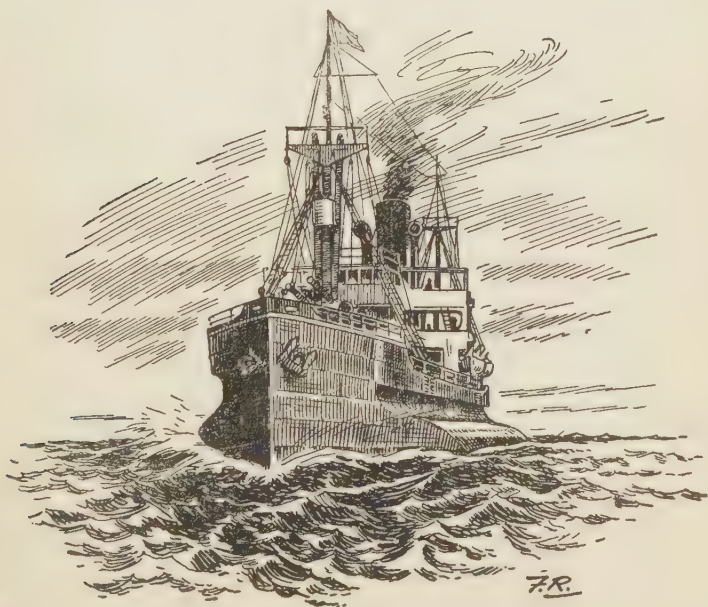
On these ships the engines and boilers are in the stern, and sometimes, too, the bridge is there, with the funnel rising from behind it, in a position which few sailors can accept as normal. Sometimes, again, the bridge and a small deck house are amidships. On these tankers the propelling machinery is in the stern in order that the cargo may be insulated to the greatest possible extent from the fires. Incidentally, too, it is the empty tanker that requires the most care, for just as an empty gasoline tin will explode while one filled to overflowing with gasoline will not, so the

empty tanker, reeking with the gas left by the oil it carries, is more apt to explode.

The turret steamer falls into almost any category. It is built in order to save money on certain port and canal dues and other taxes, and its appearance is perhaps the weirdest of that of any ship, save, perhaps, the antediluvian whale-backs once so common on the Great Lakes. Below the water line these turret steamers are much the same as other freighters, but from there up they are vastly different. Just above the water line their sides are turned in until they are almost a deck. These "decks" run forward nearly to the bow and aft almost to the stern. But the central portion of the ship from bow to stern is raised ten or a dozen feet above these strange side "decks," which in reality are not decks at all, but only sections of the sides of these strange hulls. The turret ships have few, if any, advantages over more normal ships, their only purpose being to save what money they can in tolls that ships less strangely designed are forced to pay. The turret ship is only the naval architect's way of making it possible for the ship's owners to take advantage of certain technicalities in wording. They are few in number and are of minor importance.

In these days of large shipments it does not usually pay owners to send ships of small tonnage on long sea voyages. Few steamers of less than five or six hundred tons make voyages across the Atlantic, for instance. Time was, and not so long ago, when a five-hundred-ton clipper sailed half-way round the world, but steam and steel have made deep-sea cargo ships much larger than they were, and the smaller fry are kept in the coasting trades or busy themselves in the Mediterranean or other more or less landlocked waters. These "coasters" seem to be as diverse in design as naval architects are capable of producing. Every coast has de-

veloped its own particular type, although, of course, the fundamentals of their construction are basic and permit of little change. Many of them cross the North Sea, and consequently must be seaworthy, for the North Sea has a habit of being rough. The Irish Sea is filled with them—of many shapes and sizes. European ports seem always crowded with these little ships, which steam about their business with a sort of jaunty cocksureness that is amusing in smooth waters. But they lose that jauntness when they poke their noses into the ocean swells, and as they roll and pitch along their way they have a worried but determined air. Europe is the home of more of them, perhaps, than all of the rest of the world combined. America uses schooners or sends out



A TURRET STEAMER

These strange vessels are comparatively rare, and seem to be passing away entirely.

ocean-going tugs with long tows of ancient ships once proud under their own canvas, but now converted into barges with stubby masts and sawed-off bowsprits.

Now and then one sees an ocean-going car ferry, carrying trains of box cars across some narrow arm of the sea. A notable one of these—the *Henry M. Flagler*—runs from Key West to Havana, carrying American freight trains to Cuba and Cuban trains back, in order that the freight need not be handled at each end: from car to ship, and again from ship to car.

The tourist, too, is sure, sooner or later, to travel on fast express steamers that cross similar narrow straits. The cross-channel steamers between Calais and Dover, the small ships from Copenhagen to Norway and Sweden, and others, are of this type. Their runs are short, and their schedules often are set to meet trains. Consequently, they are powerful, speedy, and sometimes most uncomfortable. But being meant for passengers, they are attractive, in their way. Sturdy, self-reliant, fast—they are perfectly adapted to the work that they perform.

Another type of vessel is the passenger ship that runs between ports not widely separated on the same coast. The United States has many of these. The ships running between Boston and New York are fast and well equipped. The lounges and dining saloons are handsome, and the state-rooms, while they are small, are thoroughly comfortable. These ships are popular, and many travellers prefer the all-night ride on them to spending five hours on the train. Other ships run from New York to Norfolk; from New York to Charleston, Savannah, and Jacksonville. Others still make the longer voyage from New York to New Orleans. On the West Coast similar ships run regularly from Los Angeles and San Francisco to Portland and Seattle and return. Every continent has some ships in similar services, and they often

reach ports which have no important land communications system. Such ships connect Japan and Korea; Ceylon and India; ports along the African coast; Marseilles and Tunis; and run on countless other routes. They are comfortable for short voyages, but many of them would not do well at transoceanic work, for in their size and their accommodations they are not comparable to the great ocean liners.

So far all the ships I have mentioned, save the Great Lakes freighters, float in salt water. But rivers and lakes the world over are often busy with ships, some of them of such size as to place them in a class with ships intended for the deep sea.

The greatest fleet of ships in the world on fresh water is the fleet that busies itself on the Great Lakes. During the winter these lakes are frozen and the whole fleet is laid up, which necessitates unusual activity for the rest of the year in order that they may pay their way. From Duluth, on Lake Superior, to Buffalo, on Lake Erie, these ships sail back and forth, deeply laden with the ore of Minnesota or the grain of the great Northwest. Piers specially designed to load the ore carriers pour huge streams of ore into their holds, and within a few hours of their arrival at Duluth the ships are on their way back to Gary or Cleveland or Erie. At these ports the cargoes are taken from their holds at such a speed as is not equalled at any salt-water port in the world.

The freighters of the Great Lakes make up the greatest part of the fleet, of course, but passenger ships comparable to almost any of the "intermediate liners" in the world sail regularly from half-a-dozen of these inland ports. Car ferries, too, are used by the railroads to take great freight trains across the lakes in order to save the land trip around. Ice-breakers, also, are used to keep open channels through the ice in order that ships may sail in winter. The ice-breakers are powerful ships whose bows are so cut away as to

make it possible for them to ride up on the ice, as their powerful propellers drive them along. The ice is broken by the weight of the ship, the bow of which is built of exceptional strength to stand such rough usage. Such ships are used, too, in the Baltic, in Russia, and in Siberia, but little use is found for them elsewhere, and they are rare.

But other inland waters have developed other types of ships. The Rhine, because of its rapid current, has necessitated the building of fast steamers able to make headway against it—fast, small steamers that slowly make their way up stream and scurry rapidly down, laden with passengers or with freight, depending on the service for which they have been built.

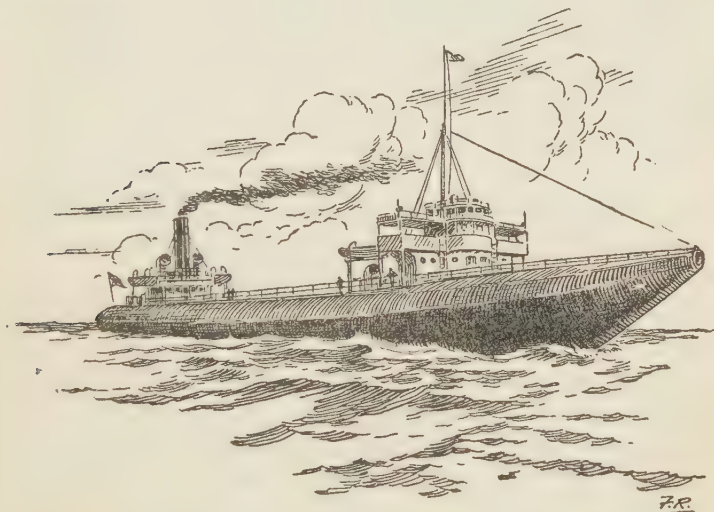
The Seine, particularly at Paris, has a most attractive type of passenger boat which has always reminded me of a Fifth Avenue bus mounted on a hull. True, their lines are better than those of the bus, but their whole appearance, nevertheless, suggests a bus. They are long and narrow, sharp and fast, and carry many passengers along that historic river beneath the many bridges.

River boats in America are vastly different. The early Mississippi River boats were scows with stern wheels. These developed into strange boats with decks supported by what seemed to be fearfully weak timbers. They were high and wide, with blunt low bows and expansive forward decks. They usually possessed two funnels, rising high above the topmost deck and standing beside each other. The tops of these, and every place else on the boat that lent itself to decoration, were decorated with gewgaws and scrollwork. The pilot house stood high above the topmost deck, and in it was a steering wheel that sometimes was so great in diameter that it was swung through a slot cut in the deck, in order that the pilot, who was a vastly important person, could handle the spokes.

These ships burned wood, and great was the rivalry between them, and great the races that were run.

Mark Twain has told the story of these picturesque boats, and his story is their history. It could not be improved upon.

But the famous old steamboats of the Mississippi are gone. A few of the species still ply up and down, and some find



A WHALEBACK

A strange type of cargo steamer once common on the American Great Lakes, but gradually disappearing.

their way up the Ohio and other tributaries, but the life seems gone from them. The romance of the Mississippi steamboat is dead.

But a type of river steamer still in use is the one so common on the Hudson. Huge ships these are, with many decks, of great breadth, for often they are side-wheelers and their decks are carried out to the outside of the paddle boxes or, if they are propeller driven, still their decks reach out over the

water. Deck on deck is piled one upon another, until the larger of these steamers may sail from New York to Poughkeepsie and West Point with as many passengers as the *Majestic* is equipped to carry. But they are not to be compared to the *Majestic* any more than a trolley car is to be compared to a Pullman.

This chapter is a hodgepodge, and contains as great an assortment of goods as a country store, so I may, perhaps, be permitted to jump from the river steamers, to which I have done scant justice, to the tugs and other harbour craft that are occasionally to be seen about the many-decked river steamers at such a port as New York.

Perhaps the ferries are most in evidence as they shuttle back and forth from Manhattan to Jersey City and Hoboken, to Weehawken and Fort Lee, to Staten and Governor's islands, and to half a dozen slips in Brooklyn.

These ferries are powerful vessels, and are capable of getting quickly under way. They have no bows or sterns—or, if you prefer, each end is bow or stern, depending on the direction the boat is travelling at the moment. The two ends, to make it plain, are identical. Each is round on deck. Each has a sharp "cut water" over which the round-ended deck projects. Each has a rudder, and each a propeller, save the old-fashioned ones—of which there are a few still in existence—that are driven by side paddle-wheels. The ends of these ferries are rounded and the slips at which they dock are so constructed as to fit the bows perfectly—so perfectly, in fact, that the automobiles and trucks with which the ferry is generally crowded drive ashore without a gangplank.

In order to make simpler the task of docking these nimble craft two great rows of piles are driven into the harbour mud so that the ferries, entering between the outermost ends of these two "fences," where they are at some distance from each other, are led directly to the slip by the converging



A GREAT LAKES FREIGHT CARRIER

This type of ship is eliminating the whaleback on the Great Lakes, and is used largely to transport ore and grain.

lines of piles. Once the ferry's nose has touched the slip, great hawsers are passed aboard and are made fast, whereupon special windlasses on the slip take up the slack and the boat is made fast, in hardly more time than it takes to tell of it. These ferries are sometimes of considerable size, but none of them are comparable in tonnage to anything more than the smallest of deep-sea steamers.

In a modern harbour there is another type of boat more numerous than ferries, and, from the point of view of the deep-sea sailor, more important. This is the tug.

A tug is a towboat, and once a sea-going ship has reached a harbour, she is largely dependent on that harbour's tugs. In appearance, at least, European tugs are very different from American.

In British and German and French ports, and elsewhere on the continent, one sees many paddle-wheel tugs—a thing

unknown, or nearly so, in America. American tugs are universally propeller boats, except on shallow rivers, where paddle-wheel steamboats sometimes are made to do the work of tugs.

An American tug is a busy-looking boat. Her bow is fairly high, her deck slopes aft in a rather marked curve. Her stern is low. A deck house extends from the "towing bits," or heavy built-in posts to which the towline is made fast, up to within ten or a dozen feet of the bow. This deck house is not high—hardly higher than a man's head—and contains a galley and a mess room, besides entrances to the boiler and engine rooms. On top of this, at its forward end, is the wheel house, as high as the deck house on which it sits. Astern of the wheel house is a huge funnel for so small a boat, and astern of that sits a lifeboat, resting in its "chocks."

But the surprise comes if an inquisitive observer goes to a local shipyard and sees one of these small steamboats in a floating dock with her bulky underbody visible. What stands above the surface seems but little compared with what is below. She may draw eight or ten or more feet. Her body lines are very full, and at her stern is mounted a propeller that seems almost large enough for a good-sized freighter. And it is, for these boats have not only themselves to propel; they must meet incoming ships which are more or less helpless to direct their movements in such limited spaces as are available in a harbour. If the new arrival be small, one tug can readily place her beside her pier. If the ship be the *Majestic* or the *Leviathan*, then a dozen or more tugs must push against her mighty side, or puff great clouds of steam as they strain at great hawsers before the giant is safely at her berth.

Every harbour needs these little workers, and their work is important, but there are other ships whose work is of a different sort, and even more important. These are the dredges that keep a harbour's channels open, or cut new

ones or widen the ones already there. I have not the space in which to go into a description of these grubbers in the mud, but I can mention a few of their more salient points.

There are several kinds. A suction dredge lowers a great pipe into the harbour mud and pumps great quantities of mud-charged water to the surface. This is run into tanks where most of the mud settles while the water runs over the top. In some cases it is possible for the pipe carrying this mud and water to be led ashore where a low spot is to be filled or where the mud is needed for some other reason. Here the water trickles gradually away, and the troublesome mud that had been silting up a channel is converted, perhaps, into valuable city property.

Another type of dredge carries an endless belt on which are great ladle-shaped containers, called "buckets." One end of this belt is lowered to the bottom. The belt is set in motion, and each gigantic "bucket" dumps the mud of the harbour bottom into a great "well" built into the ship which is capable of carrying a startling quantity.

There are other types of less importance than these, but already this chapter has grown beyond the length assigned to it and I must bring it to a close. To pretend for a moment that I have amply described the ships I have mentioned would be, of course, ridiculous. I have done hardly more than mention the more important and more picturesque types of steamships that exist in the world to-day. A book could be written on any one of them, and my greatest hope is that I may interest a few readers who will go to other volumes more complete than mine, in order to learn more of some phase or another of this fascinating subject. Should I be so fortunate I shall be content, for one volume cannot do more than outline what can be found in countless others that have specialized on a thousand phases of the subject I am attempting to discuss.

CHAPTER VII

SHIPS OF WAR

MUCH of the story of ships is contained in the story of ships of war, which, from time immemorial, have been vital factors in the lives of nations. The Egyptians fought battles on the sea. The Greeks saved their civilization from the armies of Xerxes by defeating the ships of the Persians at Salamis. Rome defeated Carthage because Rome secured the upper hand on the sea. It is true that much of the story of the Punic Wars is the story of Hannibal and Hamilcar, but while Hannibal marched his army from Spain across the Pyrenees, across France, across the Alps, and finally into Italy, where he spent years harrying the land, Carthage owed her downfall to the ships of Rome, as Hannibal owed his final defeat by Scipio Africanus to those ships. Similarly Napoleon, two thousand years later, owed the collapse of his plans not so much to the defeats he suffered on land as the defeats he suffered on the sea at the hands of Nelson and the British Navy.

It is not, however, within the province of this book to discuss wars and battles on the sea. The person interested in that important subject should read Admiral A. T. Mahan's "The Influence of Sea Power upon History" in order to gain a clear picture of the great phases of that subject. But all of this is outside the range of this book, which deals only with the types of ships and their development.

The first warships of which history gives any account were those of the Egyptians. They differed little from the other ships of the time except in having affixed to their bows

a metal ram. This, however, was well above water. When these ships were in action the sail was rolled up and made fast by loops of line to the upper yard. They were driven by large paddles, and were steered, as well, by paddles, many being required. Egyptologists tell us that the Egyptians, between 3000 and 1000 B. C., fought occasional naval battles with people as far distant as those of Sicily, for Egypt seemed to have a fascination for all the Mediterranean peoples even of this early day, and occasional forays were made against the Egyptian coast.

The Phoenicians came next as a sea-going people, and it



AN ENGLISH WARSHIP OF THE TIME OF HENRY V

By the time this ship was built hulls had grown considerably in size over what they had been at the time of William the Conqueror, and the era of lavish decoration was well under way. The numerous decks of this ship were not unusual for the time.

was they who so greatly developed ships. So little, however, is known of Phœnician ships that it is necessary, in this hurried account, to pass them by in order to take up the Greek ships of which many records are still extant.

In Chapter I, I have mentioned the galleys, but there are many things concerning them upon which it is interesting to enlarge.

These ancient war vessels are divided into two major types—"aphract," or those which had no protection for the topmost tier of rowers, and "cataphract," or those that had a raised bulwark which shielded them from the sight and arrows of the enemy. These two words mean, literally, "unfenced" and "fenced." In other words, the cataphract ships had a "fence" built up above their sides to shield the oarsmen, while on the aphract ships this "fence" was not installed. Both these types had upper and lower decks, although the cataphract type was higher than the other.

The oars used on these ships were not so large as one might think. On a trireme, or three-banked ship, the oars of the upper bank were about fourteen feet long; the next lower oars were about ten and a half feet, and the oars of the lowest bank were about seven and a half feet long. Even the topmost oars on the "tessereconteres," or forty-banked ship, which some questionable authorities mention as having been built, are said to have been but fifty-three feet long, but as the seats of the rowers are said to have been two feet apart vertically it is difficult to see how a fifty-three foot oar, of which perhaps a third was inside the ship, could have reached to the water. But these forty-banked ships sound more like imaginary craft than like real ships.

In the cataphract ships the lower deck was only about a foot above the water line. Below this deck was the ballast, and through the deck were cut a number of hatches through which buckets could be lowered in order to bail out the al-

most ever-present bilge water, for these ships, particularly when they were subjected to the strains coincident to sailing in a seaway, were more than likely to leak at an uncomfortably rapid rate.

The backbone of these ships was a heavy keel, below which was fitted a false keel, used, apparently, to take the



A BRITISH LINE-OF-BATTLE SHIP, 1790

This awkward ship is one of the type that made up the great fleets that fought, for instance, at Trafalgar. Nelson's flagship, the Victory, is of this type.

wear that resulted from hauling the ships up on to the beach.

Above the keel a keelson, similar to the keelsons of to-day, was fitted, strengthening the keel and serving, also, as a strengthener to the ribs which were fastened beneath it.

The bows of these ships were very strongly constructed, for battle tactics called for the use of the ram. The ram,

instead of being above the water, as it was on the older Egyptian ships, was at the water level, and was strengthened by the heavy timbers which formed the stem. In order to strengthen the hull still more, and to prevent as much as possible the strain of ramming from springing the seams, strong cables were wound once or twice around the whole hull from bow to stern. These were drawn up with levers and bound the ship tightly together, particularly as the cables shrank when they were wet. All these precautions were essential, for the ram on these ships was about ten feet long, and was seconded by a somewhat shorter ram above the water line.

The Athenian triremes were all about the same size—about one hundred and thirty feet long—and most of their equipment was standardized so that it was really interchangeable. The crews of these ships numbered a few more than two hundred. The rowers numbered one hundred and seventy, and there were ten or a dozen marines and about a score of seamen.

In building these triremes the frame was first set up and the ribs were covered on both sides with planking. Then around the outside of the ship at the water line a heavy timber was attached which, at the forward end, was carried out to form the ram, which was heavily sheathed with metal. A little above this strengthening timber there was another one similarly built, ending in the secondary ram, which sometimes had at its end a metal sheep's head. Sometimes a third line of timbers was placed above this.

Running from bow to stern on both sides just above the topmost oars was a narrow platform, built out about two feet wide from the side of the ship. The ribs as they continued upward from this point curved inward, and their ends supported the cross beams that bound the ship together over the rowers' heads and also served to support the deck.



THE AMERICAN FRIGATE CONSTITUTION

This ship set a new style in frigates, for she was the largest and most heavily armed frigate of her time when she was launched. She is still to be seen at Boston, and seems but a little thing in contrast with ships of to-day.

On this deck the marines, or heavily armed warriors, were placed in battle, while over their heads was stretched a stout awning of leather to protect them from the enemies' arrows. The runways at the sides served as passageways and were used by the sailors in working the ship.

At the stern there were several steps in the deck elevating it gradually above the midship deck. Here the officer in command was stationed near the helmsman, who was second in command, and who steered the ship by a cleverly arranged pair of oars—one on each side, connected and operated by ropes and pulleys.

The bow was decorated by an erection sometimes shaped like a swan's neck which was a continuation of the stem. The stern also had a highly raised timber running up and

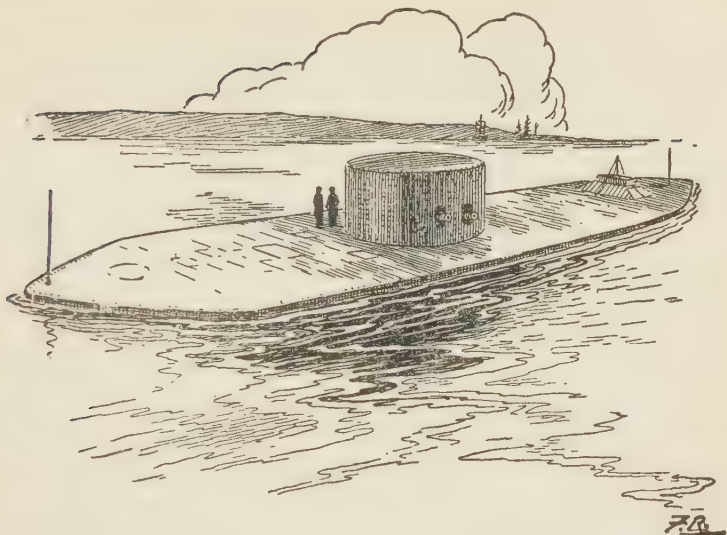
curving forward over the helmsman. These ships usually carried two masts, each spreading a single square sail, but sail was not carried in action. Often, as a matter of fact, the sails and the heavier spars were left ashore if a battle was imminent.

These galleys, for many centuries, were light craft, meant for speed, but as more strength was demanded in order to make possible hulls that could withstand the shock of ramming, the ships became heavier and heavier, which, in turn, demanded more oarsmen, which, again, brought larger ships into being, until, when Rome became the mistress of the sea, five-banked ships had become the standard, and the three-banked ships were relegated to a second place.

Then Rome invented the "corvus" or great hinged gangplank with its heavy barbed end. This gangplank was swung at the forward end of the ship and was loosely hinged to the deck, being kept upright by a tackle holding it to the



A STEAM FRIGATE—THE U. S. S. HARTFORD
Which was used in the American Civil War by Admiral Farragut.



THE MONITOR

The first armoured ship to mount a turret. This is the ship that fought with the Merrimac the first battle between armoured ships.

mast. When an enemy's ship was approached the Romans did not attempt to ram, but ran alongside, let go the tackle, and the heavy corvus fell to the enemy's deck, where its metal barb fastened itself in the deck planks. Thereupon, the soldiers, with whom the Romans crowded the decks of their ships, rushed across and the sea battle became a mêlée.

For nearly two hundred years these heavy ships were the "battleships" of the Roman fleet. But at the Battle of Actium, in 31 B. C., Mark Antony's ships, which were of this type, were soundly beaten by light, swift two-banked ships called the Liburnian biremes.

Thereupon these Liburnians became the most important ships of war, and later grew into the great galleys of the Middle Ages. The later development, however, tended to the use of one bank, while the oars grew longer and longer

until they reached such size that several men were used on each—sometimes as many as seven men being employed on a single oar. This form of rowed war vessel was in more or less common use, principally in the Mediterranean, until the beginning of the 17th Century.

In the north of Europe the Viking influence was felt plainly for many years, but finally it was outgrown, or practically outgrown, largely, perhaps, because of the introduction of the raised forecastles and sterncastles, and the introduction of more highly developed rigging.

During the Crusades most of the fleets consisted largely of merchant ships, which were more or less converted into war vessels by the addition of raised castles. These castles were, perhaps, of Roman origin, for the old Roman ships sometimes had somewhat similar contrivances at bow and stern.

The invention of gunpowder brought about many changes in ship design. At first the guns were small and were pivoted in the rails, as they were on Columbus's ships, but later, as larger cannon came into use, a new arrangement of them became necessary.

Galleys found it difficult to use many cannon, for they could not be mounted amidships, that part of these ships being crowded with rowers, who, by the way, were now seldom below deck. Guns, consequently, had to be mounted at bow and stern, where only a few could be installed. This, then, was one reason for the decline of galleys, for ships driven exclusively by sail were able to mount cannon on deck, where many of them could be carried and fired over the sides.

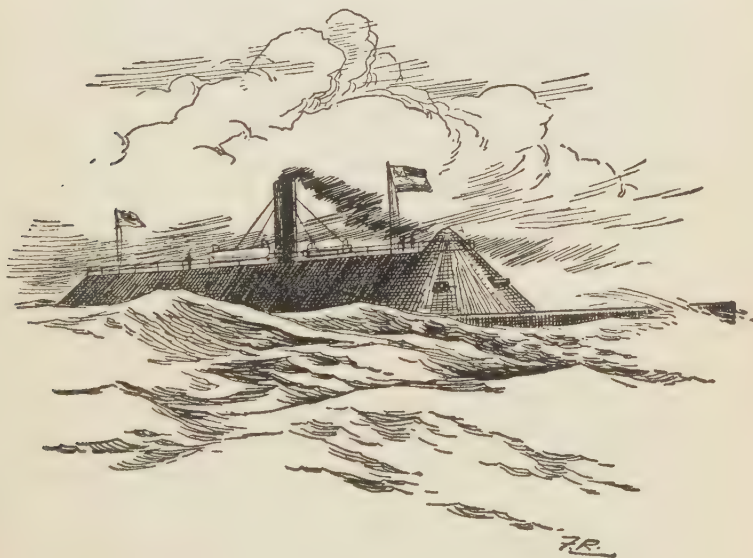
As ships increased in size it became possible to mount cannon below deck and to cut portholes through which they could fire.

It was along these lines that warships next progressed, until, at the end of the 18th Century, the line-of-battle ships

were great unwieldy affairs with three gun decks below, on which were mounted a hundred guns. Earlier ships had been built which had carried even more guns than this, but the guns had been smaller and consequently less effective.

For those interested in the details of the development of warships from the time of the introduction of gunpowder down to the beginning of steam I recommend two books—"The Royal Navy," by W. Laird Clowes, and "Ancient and Modern Ships," by Sir G. C. V. Holmes. I have the space to describe only the final forms that the larger ships took ere the introduction of steam and steel changed radically the design of all naval ships.

At the end of the 18th Century and the beginning of the



THE MERRIMAC

An ironclad built by the Confederates during the American Civil War. This ship proved how superior to wooden ships armoured ships could be. She was armed with a ram with which she sank the Cumberland, and her armour amply protected her from the enemy's guns.

19th the greatest warships were called line-of-battle ships. They were great unwieldy affairs, slow and cumbersome under sail, and were meant only to take the shock of battle when rival fleets met. Their sides were high, and below the main deck were three gun-decks, each carrying many cannon that fired through square ports cut in the sides. Sometimes, if the wind was abeam, as it generally was during an engagement, the lower ports on the side away from the wind could not be opened because the deck was so low that the "list" of the ship would have allowed the water to enter, perhaps in such quantities as to sink her. Gradually, however, this lower deck was raised until all the guns on the "lee" side could be used except in heavy weather.

The *Victory*, Nelson's flagship at the Battle of Trafalgar, was a typical line-of-battle ship, and in the hearts of Britons she occupies much the same place as with Americans the frigate *Constitution* occupies. These two ships—the one a line-of-battle ship and the other a frigate—are of the two types that, toward the close of the era of sail, were the most important ships of naval powers. They occupied in their day positions similar to those occupied by the battleship and the cruiser of to-day. In describing these two particular vessels, then, I shall be describing not merely two outstanding ships, which, fortunately, are carefully preserved by the countries for which they fought, but shall also be describing the two most important types.

The *Victory* was built in 1765. She is 186 feet long, 52 feet wide, and her tonnage is 2,162. She carried 100 guns on her three gun-decks, and is, in rig, a ship—that is, she carries three masts, spreading square sails, the mast farthest aft carrying as its lowest sail a spanker. Her head sails—that is, the sails at the bow—were jibs set between the foremast and the bowsprit, which was elongated by the addition of a jib boom and a flying jib boom.

Her shape is clumsy, her sides are high, but the highly raised forecastle and sterncastle are entirely missing. A section of the bow is called the forecastle, but only the name is left of the earlier raised structure from which the name came. Astern there is a slight sign of what, centuries before, had been the sterncastle, for there is a raised deck,



A TORPEDO BOAT

About the time of the Spanish-American War these boats were common in the navies of the world. Now they are eliminated, and their successors are the torpedo-boat destroyers, now called destroyers.

called the quarter-deck, in evidence. The stern itself is a highly ornamental affair, fitted with many windows and with much scrollwork, and, at least in the eyes of the present day, is anything but nautical in appearance.

This high-sided, bluff-bowed craft carried about seven hundred men in her crew, although where they kept themselves is, to the average person of to-day, a mystery. They slept, of course, in hammocks, and these were lashed to their hooks between decks. So thick were they that when the

crew had turned in the whole deck looked like a cave filled with strange huge bats hanging parallel to the ceiling.

The guns on these ships were crude affairs. They were muzzle loaders, of course, and were generally cast of brass or iron. They were mounted on awkward wooden carriages which were set on four small wheels. But such a weighty implement mounted on wheels needed much careful attention to keep it tightly secured when the ship, once outside her harbour, ceaselessly rolled from side to side, even in an almost glassy sea, and, in a seaway, rolled and pitched and rolled again, until, should one of these wheeled monsters have broken its fastenings, it might readily have become more dangerous than an outside enemy. Victor Hugo's powerful description of such a scene in "Ninety-three" presents a graphic picture of the danger that such a misfortune would bring with it.

These heavy-wheeled cannon were made fast in their places, each with a square port through which it could fire; and a gun-deck with thirty or more of these polished juggernauts lined up along its two sides, with the decks holy-stoned, and with the gear of every description carefully stowed in place, had a most businesslike appearance.

In battle, however, with the air thick with powder smoke, with sanded decks and wounded men, with piles of ammunition and half-naked gunners apparently gone mad, with splinters split from oaken beams and gaping holes where the enemy's guns had wrought their havoc—then the deck was bedlam. Roars of cannon, fired in broadsides, orders, oaths, and shrieks of dying wretches—stabs of fire as the cannon belched, glowing matches in the hands of powder-blackened men, messengers running here and there, officers standing by, strained, intent, and heedless of everything save the guns they commanded—there was a scene worthy of the pen of Dante.



H. M. S. DREADNAUGHT

The first all-big-gun ship, and the one that gave its name to present-day battle-ships, which are universally called dreadnaughts or superdreadnaughts.

And such a sight as a fleet of these ships presented as it grappled with a rival fleet perhaps equally strong. Two lines, each of a score or more of these awkward giants—first they manœuvre for position, each strung out in single file, each with sails set, each silent, each watchful, each anxious. Slowly they converge. Closer and closer they come, their ports open, the black muzzles of the cannon protruding. On the gun-decks men are waiting quietly, peering out, waiting for the command to fire. Above, on the quarter decks, groups of officers with their awkward field glasses, watching the enemy, watching the flagship. Aloft, in the masts, groups of sharpshooters with muskets ready, waiting for an opportunity to bring down the officers and men on the decks of the enemy's ships.

Closer the ships sail and closer still, still noiseless save for

the gurgle of water at the bows and the sounds of the rigging. Then on the flagship a string of flags is run up and the attacking fleet changes its course sharply toward the enemy. Another string of flags and a crash of guns—the battle is on. Great clouds of smoke, more cannon roars—the enemy has answered. Closer still, and closer, until each ship is alongside one of the opposing fleet. Grappling irons are thrown over the rail, and the two fleets have become a long tangled row of duelling pairs, each locked tightly to its adversary, their sides grinding together, their rigging tangled. An hour, perhaps, of awful havoc. The line is broken, ships drifting here and there. Broken masts and spars clutter the decks. A ship catches fire and her magazine explodes, and as she sinks the victor cuts the lines that bind the two together and stands on to help a friend. An hour or two—maybe a little more—and the victory is won. History is made—perhaps Trafalgar has been fought and the whole world will feel the effect. Such were the duties of the line-of-battle ships.

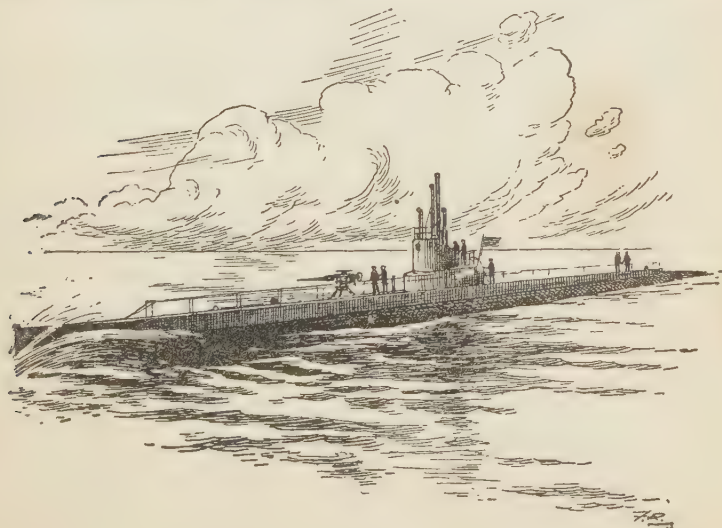
But the frigates were built for a different work. They were the cruisers of a hundred years ago. They were the commerce destroyers, the raiders. A frigate was a ship which carried guns on the main deck and on one gun-deck below. Sometimes they sailed with other ships, but more often played their game alone. The *Constitution* was one of these, and an important one. Not only did she win battles: also she affected the design of ships.

She was launched in 1797, and was, actually, an improvement on the frigates of the day. She was 204 feet long, 43.6 feet broad, and she carried thirty 24-pounders on her gun-deck, twenty-two 32-pound carronades on the quarter deck and forecastle deck, besides three “bow chasers” or long guns for use when pursuing a fleeing ship. Thus she had fifty-five guns (although later this was reduced) and conse-

quently far outclassed foreign frigates of the day. They carried from thirty-two to fifty guns, and these of lighter weight. While the main battery of the *Constitution* consisted of 24-pounders, foreign frigates used 18-pounders. A 24-pound shot is naturally more effective than an 18-pound shot from the same type of gun.

But not only was the *Constitution* heavily armed. She was built of timbers of about the size of those used in line-of-battle ships, and so was much stronger than other frigates. As a matter of fact, she so outclassed the frigates of the British Navy that several line-of-battle ships were cut down until, technically, they became frigates, in order that they might meet her on more favourable terms.

The *Constitution* was a more graceful ship than the *Victory*, as frigates, as a class, were more graceful than all line-of-battle ships. They required more speed, and so had finer lines. Their sides were not so high, their bows less bluff,



A SUBMARINE

their sterns more finely designed. Line-of-battle ships were hardly more than floating wooden forts, carrying as many guns as possible. Frigates were fine ships, having all the qualities of fine ships, and carrying modified batteries.

So regularly did the *Constitution* defeat other frigates, and so simply was she able to refuse battle with superior forces, that the British Navy profited by her advantages and built similar ships. But the end of the era of sail was approaching, and before much could be done in the further perfection of ships of this kind, new warships propelled by steam had come into being, throwing into the discard both the line-of-battle ships and the frigates of an earlier day.

Following the War of 1812 there were no engagements of great importance in which warships played a part until the Crimean War, in 1855. During this period both steam and iron had been utilized by the designers of warships, and navies had made the first of the great steps that changed the fleets of the world from the wooden sailing ships of Trafalgar to the steel monsters of Jutland.

Typical warships of the most improved design just prior to the Crimean War were not greatly dissimilar from the line-of-battle ships and frigates of the War of 1812 except that they used steam as well as sails. They were larger, it is true. Such a ship was the British *Duke of Wellington*. She was 240 feet long, 60 feet wide, and displaced 5,830 tons. Her engines were of 2,000 horse power, and her speed under power was a trifle less than ten knots (nautical miles per hour). She carried 131 guns on four decks. This arrangement of guns was similar to that formerly used on line-of-battle ships, which sometimes carried guns on the upper deck as well as on the three gun-decks below. She was, then, one of the line-of-battle ships of her day, although this term was changed about this time to "ships-of-the-line." Other somewhat smaller ships, propelled by steam and sails and with

guns placed similarly to those of the earlier frigates, had come to be called "steam frigates," or sometimes still were called frigates. The *Hartford*, Admiral Farragut's flagship at the Battle of Mobile Bay in the American Civil War, was of this type.

At about this time, too, explosive shells were introduced,



A MODERN DESTROYER

This type of ship was originally designed to protect the larger ships from torpedo boats, but now that duty has been eliminated by the elimination of torpedo boats, and destroyers have many uses with the fleets to which they belong.

and as these were far more formidable than the solid shot of earlier times, naval men set about protecting ships in order to reduce the effectiveness of this new form of attack.

Iron had been introduced a few years earlier as a ship-building material, and so iron, naturally enough, was used as armour on some of the ships sent to Crimea, for wooden ships of the line had been badly battered by the guns of the Russians when a combined naval force of British and French

ships had attacked a fort near Sebastopol. Both the British and the French instantly began to build armoured ships for use in the Crimean War. The British ships were not completed in time, but three of the French ships went very successfully through an engagement with a Russian fort in 1855.

These ships were, of course, awkward, heavy, and slow, but they did prove the value of armour, and so both the French and the British went to work placing armour on wooden ships and building ships of new design.

In 1859 an iron frigate called the *Warrior*, a ship 380 feet long, displacing 8,800 tons, was begun by the British. A wide strip of armour $4\frac{1}{2}$ inches thick was placed on each side. This armour strip was 213 feet long and was wide enough to extend from a little below the water line to the upper deck. Both bow and stern were unprotected. This ship was, in appearance, merely an enlargement of the wooden steam frigates that had preceded her, but she made the surprising speed, under power, of 14 knots an hour.

While she was being built a new type of cannon was perfected which gave greater power with less weight and she was armed with these improved guns, each of which was of seven-inch bore and weighed between six and seven tons.

Then came the American Civil War and a still newer type of armoured ship was invented. This was the ship with a turret, and the first of these was the *Monitor*. She was designed by Captain Ericsson, the same man who perfected the screw propeller, and the turret, the most important feature of this ship, is the original one from which the highly perfected turrets of to-day have developed.

The idea of mounting guns in turrets had been suggested before, as a result of the experience gained in the Crimean War, but Ericsson, when he designed the *Monitor*, was the first to put the idea into practice.



A MODERN SUPER-DREADNAUGHT

*Which carries the heaviest type of guns, and is protected by heavy armour.
Its speed is less than that of cruisers.*

The *Monitor* was a strange-appearing ship. The fact that she was said by the Confederates to be a “cheese box on a raft” gives some idea of her appearance. She was 170 feet long, 41½ feet wide, and displaced about 1,200 tons, but her appearance was unique. Her deck was but two feet above the water and from bow to stern she was as smooth as a paved street except for a tiny pilot house near the bow and a huge round “cheese box” amidships. This cheese box was the turret and in it were mounted two 11-inch Dahlgren guns, the *Monitor*’s only battery. The turret was about twenty-two feet in diameter and the sides of it were of iron eight inches thick. This was built up of eight thicknesses of one-inch plates bolted together. The broad smooth deck was covered with three inches of iron and the low sides

with five inches. This strange vessel was completed just in time to be sent to Hampton Roads in order to protect the wooden ships of the Union Navy from the ferocious and effective onslaughts of the *Merrimac*, a Confederate ironclad that had just sunk the *Cumberland* and set fire to the *Congress*. This ship had been the wooden frigate *Merrimac* which had been partly burned when the Union forces had abandoned the Norfolk Navy Yard. The Confederates had raised her, repaired her, cut her sides down almost to the water line, and had built a huge deck house amidships. This deck house, in which the cannon were mounted, had sloping walls which were covered with railroad rails. Harking back to the time of Greece, they affixed a huge ram to her bow, and then sent her forth against the Union ships in Hampton Roads. Their shells ricocheted from her armoured sides like hail from a tin roof. All the cannon the helpless *Cumberland* could bring to bear disturbed her not at all, and slowly bearing down upon her wooden adversary she buried her ram in the *Cumberland's* hull. Slowly the old sailing ship filled and sank, her guns still firing and her shells still glancing harmlessly from the *Merrimac's* armour of rails. The Confederate ship then turned her attention to the *Congress*, shelled her and set her on fire, and then calmly returned to her base none the worse, save for a few dents in her armour.

But during the night that followed the *Monitor* appeared, having slowly made her way down the coast from New York. The next day the *Merrimac* came out to finish her work of destruction, when the *Monitor*, a tiny ship beside her great opponent, steamed slowly toward the approaching ironclad. A duel memorable in naval annals followed—the first battle between ironclad ships.

As the two ships approached each other the *Monitor's* turret slowly revolved. The black muzzles of the two guns came to bear on her great antagonist. A double blast from

them, and the *Merrimac* reeled from the shock, but the turning turret had carried the gun muzzles on around, away from the fire of the Confederate ship. As the turret revolved the gun crew, with feverish haste, loaded again, and once more the muzzles faced the *Merrimac*. All this time the Confederate had been raining shells at her little opponent, but they glanced harmlessly from the deck or barely dented the iron walls of the turret. The *Merrimac* tried to ram, but the *Monitor* out-manœuvred her and the battle continued. A shell struck the *Monitor's* pilot house and the commander was temporarily blinded, but the fight continued. At last, however, the *Merrimac* withdrew. The fight, perhaps, was a draw, but can more properly be called a victory for the *Monitor*—the first ship to mount a turret, for the *Merrimac* never again faced a Union ship, and later in the war was sunk



A BATTLE CRUISER

A ship carrying the heaviest of guns but lacking the heavy armour of the dreadnaughts. Its speed is greatly superior to that of dreadnaughts.

by her own men to keep her from falling into the hands of their enemies.

Following this engagement many ships similar to both the *Monitor* and the *Merrimac* were built to take part in the Civil War. And others of other designs were constructed. The war ended, however, with no further important steps having been made in the design of warships.

Following the Civil War the Navy of the United States fell into decay for twenty years, but European nations continued the building of ironclad and, later, steelclad warships. In these, many experiments were made with turrets and side armour but little of permanent value resulted.

Guns were perfected, it is true, and the old muzzle-loading smooth-bores of Civil War and earlier times were succeeded by breech-loading rifles. These new guns, too, became more and more powerful and more and more accurate. Still, however, the accuracy of gunfire was not greatly improved, although it improved slowly.

The newer ships gradually eliminated sails and came to depend exclusively on their engines, just as passenger ships did during this same period, and the engines increased in power and reliability until, in the early 'nineties, many of the world's cruisers were capable of a speed of more than twenty knots an hour.

Turrets had become revolving armoured turntables carrying one or two guns, and these had been placed on an equally heavily armoured "barbette" or circular steel base through which shells and ammunition were hoisted into the turret. Side armour grew heavier and heavier, and a "protective deck," somewhat above the water line, was built in. This deck was of comparatively thin steel armour, and as it approached the side of the ship it was bent down so that it was attached to the sides at or below the water line, thus placing over the all-important boilers, engine rooms, and

magazines the protection that they needed from the enemy's shells. During this period, guns were such that an enemy's projectile would probably strike the side of the ship, and this deck, therefore, did not have to be designed to prevent the entrance of shells striking it except at a small angle. Consequently, the light armour used was sufficient. Later,



A SCOUT CRUISER

This ship is one of the Omaha class, built after the World War for the U. S. Navy.

at the Battle of Jutland (in 1916) and elsewhere, these decks were easily penetrated by shells fired at such a distance that they fell at a very steep angle.

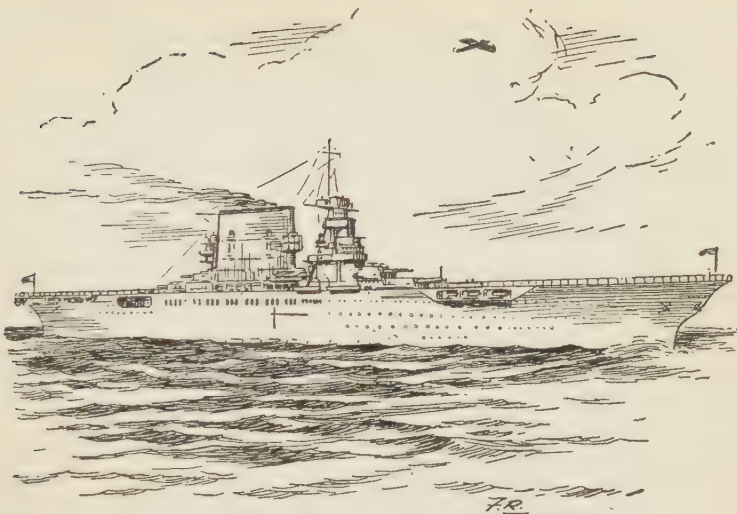
Shortly before the Spanish-American War, a new type of warship began to appear, and it created much interest because of its supposed ability to annihilate other types of ships. This new type was the torpedo boat. It was small and was very fast, for that day, being capable of twenty-one or twenty-two knots and sometimes a little more. It was a fragile affair, but it carried the newly perfected Whitehead torpedo. "Torpedoes" had been used during the Civil War,

but in reality they were nothing but mines, set off by a trigger or by contact, and capable of use only when they could be set in the path of a ship, or by being fastened at the end of a long pole could be thrust against a ship, below the water line, by another craft. Some success attended their use during the Civil War, but they were not numerous or widely successful.

The Whitehead torpedo, however, was a new development. It consisted of three parts: first, the "war head," or foremost section, filled with high explosive which was set off when its sharp nose came in contact with a solid object; second, a round steel compressed-air tank, which took up the midship section; and third, the section to which were attached propellers, vertical and horizontal rudders, and in which there was a powerful engine operated by the compressed air of the midship section. This torpedo could be plunged into the water from a "torpedo tube" and its engine would propel it for four or five hundred yards, while it was kept in a direct line and at an even depth beneath the surface by its automatic rudders.

A torpedo boat, then, small, fast, and capable of making a comparatively high speed, did seem to be a dangerous warship. But during the Spanish-American War two Spanish torpedo boats, the *Furor* and the *Pluton*, were smothered by the fire of the American ships—notably the *Vixen*, which was only a converted yacht—at the Battle of Santiago, and later another type of ship called the "torpedo-boat destroyer" was designed. This new type completely eliminated the torpedo boat.

The heavier warships had grown into weird collections of turrets. Turrets carried 12-inch guns, and 8-inch guns, and 6-inch guns, and all of these were sometimes placed on a single ship. Turrets were forward and aft and on both sides, sometimes as many as eight of them. But the 12-inch guns



U. S. S. LEXINGTON—AIRPLANE CARRIER

This gigantic ship was originally intended to be a battle cruiser, but became an airplane carrier instead as a result of the international agreement to limit capital ships.

outranged the 8-inch guns, and the 8-inch guns outranged the 6-inch guns, and so the British, seeing the fallacy of these numerous guns of various sizes, decided to build a ship armed only with the heaviest type of naval guns in use and with small guns to withstand torpedo attacks. Thus the *Dreadnaught* came to be designed. She was the first "all-big-gun" ship, and immediately she changed the design of all line-of-battle ships, or, as they had come to be called by this time, battleships. Incidentally, so great was the effect that the *Dreadnaught* had, that all the great battleships to-day are called "dreadnaughts," or, now that they have increased so much in size, "super-dreadnaughts."

The *Dreadnaught* was built in 1906. She is 490 feet long, 92 feet wide, and displaces 17,900 tons. From this will be seen the enormous increase in size that ships had gone through

since the introduction of steel. She carried ten 12-inch guns, mounted in five turrets, and in addition to these, originally carried no other guns save twenty-four 12-pounder rapid-fire guns. She could steam at $21\frac{1}{2}$ knots an hour, and the distance she could go without replenishing her supply of coal was 5,800 miles.

This ship, as I have suggested, revolutionized modern battleship design, and, since she first appeared, the leading naval powers have built ships of her type as their first line of defense. It is true that her secondary battery was found to be inadequate and that later dreadnaughts and super-dreadnaughts have increased the size of the guns in this minor battery, but they still retain the huge and powerful battery of big guns of a uniform size.

Dreadnaughts have enlarged their guns from 12-inch to 14-inch and at last to 16-inch, which, under the Disarmament Treaty signed at Washington in 1921, is the limit in size, and some of the newest ships have their guns mounted three in a turret instead of one or two, but the characteristic that made the *Dreadnaught* a dreadnaught is still a characteristic of all present-day first-line battleships.

Other types have come into existence, but unfortunately I have no space in which to discuss them. Battle cruisers are fast ships of tremendous size—they are the largest of modern warships—which carry little armour but are armed with huge batteries of the heaviest guns and are capable of enormous speed. They can make from 28 to 35 knots an hour—a speed that can be equalled only by destroyers. There are submarines, those slinking creatures that infested the North Sea, the Atlantic, and the Mediterranean during the World War. The hours I have spent on duty in the English Channel and the Bay of Biscay, leaning on the bridge rail, scanning every wave and every bit of wreckage, helping to pick up occasionally the crew of a torpedoed

steamer, searching night and day for the submarines sent out from Kiel and Zeebrugge, have not made of submarines a type of warship for which I have any love. But I realize that, despite the aversion I grew to have for them, they are marvellous structures, capable of amazing feats, and capable, too, of better, or at least not such vicious, uses as those to which the Germans put them.

But the warships of to-day—they are of almost innumerable designs and sizes and uses. A modern fleet is no longer able to maintain itself with fighting ships alone. Supply ships, hospital ships, airplane carriers, colliers, gunboats, fleet submarines, ordinary submarines, destroyers, scout cruisers, battle cruisers, dreadnaughts, super-dreadnaughts—these are some of the types that only an encyclopædia of naval information could adequately describe.

CHAPTER VIII

PORTS AND PORT EQUIPMENT

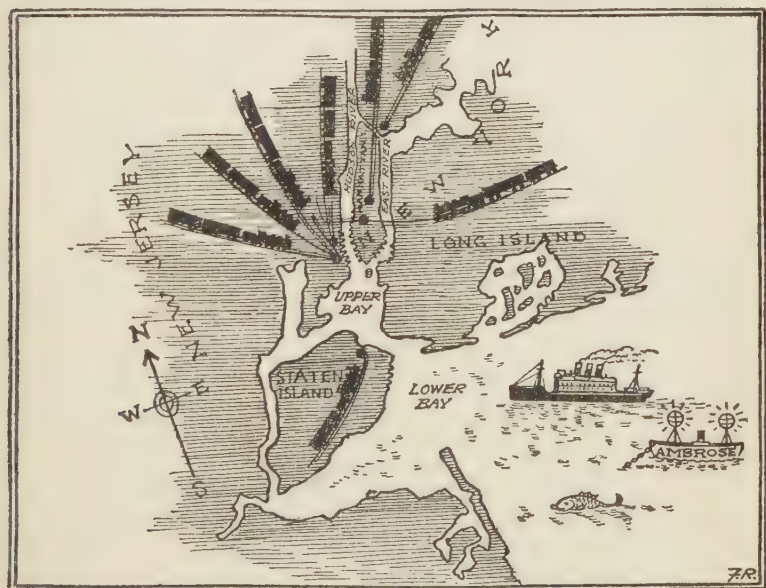
NOT all of the story of the sea is in the story of ships. Ships have always required shelter from the stress of sea, where repairs could be made, where cargoes could be loaded and unloaded, where crews and passengers could be taken on board or put ashore. In ancient times a river's mouth might have been sufficient, or a natural indentation in the coast line where a small protected body of water lay in the lee of a jutting headland. Sometimes a small bay, almost completely surrounded by land, and still deep enough for ships to ride at anchor, served as a harbour of refuge. Sometimes islands might be found that protected a small arm of the sea.

All such places along the Mediterranean coast early became known to navigation, for the early sailor was inclined to skirt the shore, fearful of the perils of the open sea. At first these sheltered spots were left, of course, as Nature had made them. Perhaps a bar at the mouth made entry difficult; perhaps the prevailing winds drove piled-up seas into the broad mouths of others; perhaps marshes surrounded others still, and in such cases these harbours were less used than those without such disadvantages.

But wherever a fine harbour existed there grew up a port, for ships, except those meant for war, have no uses save to carry the goods and passengers that originate ashore. If, on some one of these finer harbours, a port sprang up, and if a rich interior country was easy of access from it, because of a navigable river, perhaps, or because caravan routes con-

verged there, or an easy defile through some mountain range led to some rich valley not too far distant, these ports became important. They grew in size because the ease of land or inland transportation permitted the people of the interior to bring their goods for sale. Because of their increased size they attracted the makers of cloth, of leather goods, of glass, of metal ware and cutlery, and of all the great list of goods that go to make up commerce. These artisans came to important ports because the ease of distribution made it simpler for them to sell their wares.

At first, the ships being small, they could be drawn up on the beach, but as trade increased it was found advisable to



A MAP OF THE PORT OF NEW YORK

The Lower Bay has not yet been developed, but about the Upper Bay and along the Hudson and East rivers hundreds of piers are in everyday use. While New York is a huge port and while it can continue to grow for many years it has numerous disadvantages, one of the chief of which is the absence of a belt line railroad.

build warehouses and sea walls, so that goods could be stored and easily loaded and unloaded. The port having become important, it became vital to protect it from pirates and other enemies, so walls were built about it on the landward side, and sometimes sea walls were built on the water side, in which a narrow entrance was left open during the day and closed with a heavy chain or a floating barricade at night. These sea walls were often as important to shield the ports from storms as to protect them from enemies. Thus the early ports developed, and within these walls were not only all the traders with their goods, but shipyards and those who supplied ships with cordage, lumber, and sails, as well.

This simple type of port was the rule down to long after the Middle Ages. As a matter of fact, the great complete structure of the modern port has been developed within very recent times—principally since the introduction of steam.

Naturally enough such cities as Venice and Genoa, in their heyday, about or a little after the year 1200, were no longer simple ports, but by comparison with even minor ports of to-day they were simple places.

With the development of steam, however, ports became more and more complex. The increased size of ships, the great investments that demanded no loss of time in loading and unloading, the vast increase in the amount of freight and the number of passengers handled—all these, and many other reasons, compelled ports to add complexity to complexity, until the person unfamiliar with the great doings of a busy modern port stands aghast at the vast collection of quays and docks, jetties and sea walls, steam tugs and canal boats, ferryboats and barges, floating grain elevators and great suction dredges, ocean liners and ocean tramps, and a great variety of complicated equipment in the shape of shipyards, coal pockets, factories, warehouses, railroad terminals, and many other things too numerous to mention.

Ships do not make a port. Even a fine harbour will not do that alone. New York is to-day one of the very greatest of the world's great ports, but had Nature erected a barrier of insurmountable mountains around it, even though the harbour and the entrance from the sea had been left exactly



A MAP OF THE PORT OF LIVERPOOL

While Liverpool is much smaller, so far as mere area is concerned, than New York, it handles about the same amount of freight. Freight ships load and unload in the tidal basins while passenger steamers use floating landing stages.

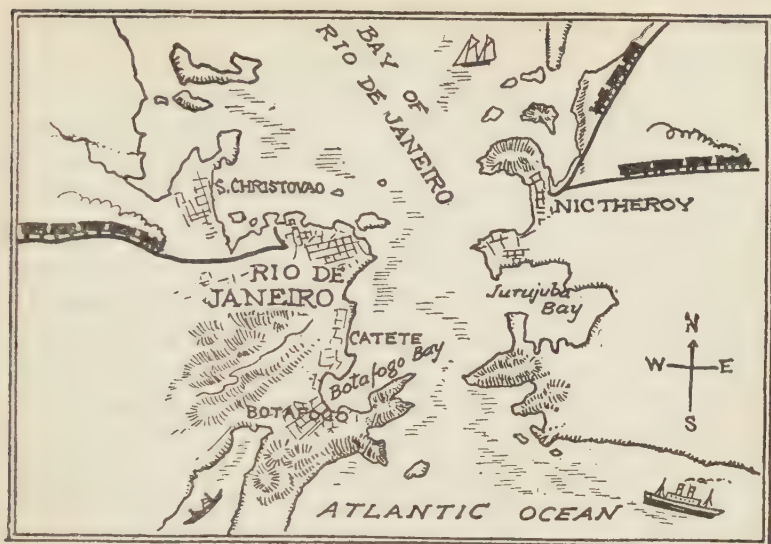
as they are now, it would have been an inconsequential place, important, perhaps, as a naval base, but unimportant as a centre of trade, for communication with the interior would have been rendered difficult or impossible, so that the wheat of the great Northwest, the iron and steel of Pittsburgh, the manufactured products of a thousand centres would have found their way to Baltimore or Philadelphia or Boston or to some other port easier of access.

Thus a port depends on two things—first, ease of access to the sea; second, ease of access to a productive hinterland.

Nor can a port become highly important if its trade is all in one direction. If it imports but does not export, ships can come loaded but must go away empty, and to do that they must charge very high and possibly prohibitive rates for the freight they bring. If the port exports but does not import, then ships must come empty before they can secure their cargoes, and the result is the same. A healthy port, then, must have a *constant and steady* stream of freight bound in both directions. Montreal would be a more important port than it is if it served a hinterland that bought in larger quantities the goods manufactured in Europe, for Montreal could export very nearly all the wheat that ships could take from her harbour. But her imports are so much less than her possible exports that ships cannot afford to come in sufficient numbers to carry away all that she could send, especially as the wheat can be, and a large part of it is, diverted to Philadelphia, New York, Boston, and Portland.

Imagine a rich country, producing goods in large quantities which are salable in foreign lands, and anxious and willing to buy, in equal quantities, the goods of these foreign lands. Imagine such a country without a single harbour—with, perhaps, a long unbroken coast of sandy beach on which relentless surges pound the whole year through. Would such a country long remain without a port? Not so. No matter how difficult and costly the task might be, a port would be *built* upon that very coast. A harbour would be dredged. Great sea walls would be erected. Vast warehouses, great quays and docks, busy railroad terminals would soon be in operation, and where Nature had made no harbour, man would have one.

But Nature is seldom so unkind. All around the world



A MAP OF THE PORT OF RIO DE JANEIRO

Rio Bay is probably the finest in the world, but mountains paralleling the coast form a handicap to the easy transportation of goods inland.

are natural harbours which need only the clever hand of man to become busy with the transfer of goods. Some, of course, have more natural advantages than others. Some are almost entirely the work of man, as others are almost entirely the work of Nature, but their natural advantages must be many ere it is worth the time of man to improve them.

The natural advantages of a port, however, are of the greatest value when they combine many things far distant from the port itself with the natural advantages of the harbour, its surroundings, and its outlet.

To cite New York once more, among its great advantages are these: First, a fine harbour, with ease of access to the sea yet with thorough protection from its storms. Second, suitable land surrounding the harbour, on which factories, warehouses, piers, and shipyards can be erected. Third,

a great and navigable river leading into a rich country. Fourth, a fine canal connecting the upper reaches of that river with a far greater land, rich in people of great purchasing and producing power, rich in mines, in farms, in factories. Fifth, routes leading overland into the interior along which great railroads have been built that reach with their network ten thousand centres that otherwise could not buy the goods imported to New York or sell their own either there or beyond the seas. These five things have created at the mouth of the Hudson one of the greatest seaports of all time. Without any one of them New York could not be the port it is, but of the five, the first two are the least important, for a harbour could be made, and had the surrounding land been a marsh it could have been built into dry land. Without the trade of the great land to the West, however, New York could not have been the port that it is to-day.

But an account of all the factors that go to make a port would take one far afield, so with only this inconsequential statement in reference to the vast economic structure that lies behind a port, I shall confine myself directly to the port itself and to its environs, its equipment, and its activities.

No two ports are identical, but the major ports of the world divide themselves more or less readily into types which I may be permitted to call the European and the American types, inaccurate as those classifications may be. I shall describe, in more or less detail, these two types, and add to this something from other ports that fall less readily under these two inaccurate classifications.

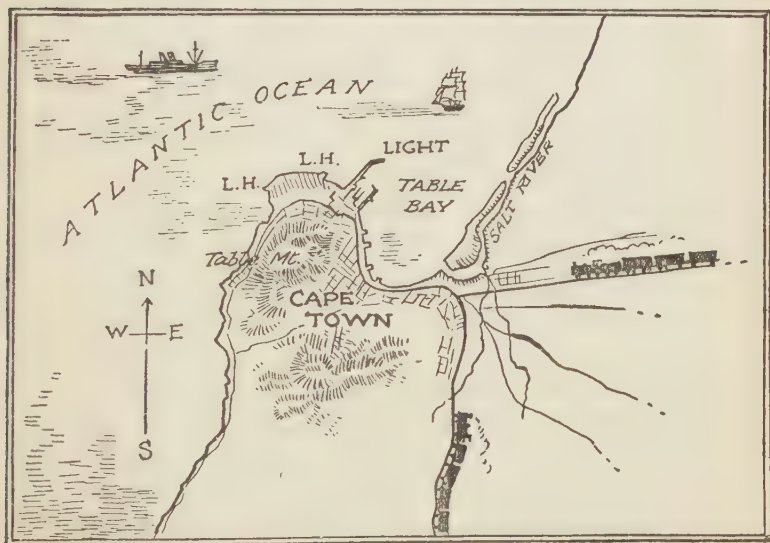
To begin with it needs to be said that mere size has little bearing on a port's ability to handle large quantities of freight. By comparison with the area of the port of New York the area of the port of Liverpool is limited, New York being perhaps six times larger. Across the Mersey from Liverpool are the Birkenhead Docks, which, so far as mere area is

concerned, are hardly larger than the Cumminipaw Terminal of the Central Railroad of New Jersey which lies across the Hudson from the Battery. The port of New York, including the New Jersey side of the Hudson and the Bay, has a developed waterfront several times as great as the port of Liverpool including the Birkenhead Docks, yet the tonnage of overseas freight handled in each of these two ports is roughly the same.

The same comparison can be made with many other European ports, which are all far smaller than New York although several equal or exceed New York in the tonnage of transoceanic freight handled.

But let us take New York and describe it, in order that other ports may be compared with it.

Entering New York Bay from the ocean a ship passes



A MAP OF THE PORT OF CAPE TOWN

Table Bay is open to the force of north and northwest winds. Before the bay could protect ships from the frequent storms blowing from these directions a series of breakwaters had to be built, in the lee of which ships could anchor.

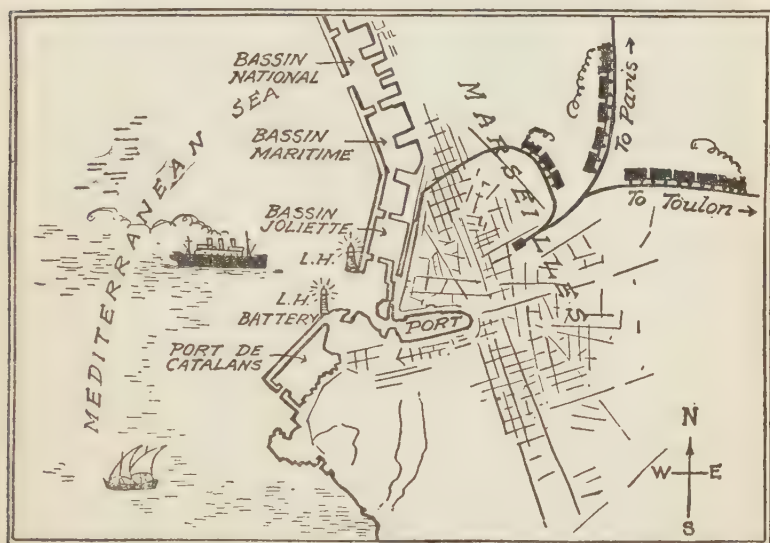
between Coney Island on the right and Sandy Hook on the left. Within these two points lies the Lower Bay, a great and largely undeveloped body of water around which practically none of the port's equipment is placed. Standing on up the channel, with Long Island on the right and Staten Island on the left, the ship enters the Narrows, a restricted passage connecting the Lower and the Upper bays. Once through the Narrows the port begins to show itself. The Upper Bay is smaller than the Lower and is roughly rectangular, while at each corner a river or a strait connects it with other bodies of water. Of these the Narrows, just mentioned, is the most important, for through it flows far and away the greatest stream of shipping. The Hudson River is second in importance, for this great and navigable stream penetrates far into the interior and is connected with the Great Lakes by the Erie Canal, or, as the newly finished improvement on the Erie Canal is called, the State Barge Canal. The other two exits from the Upper Bay are the East River—a strait connecting the Bay with Long Island Sound—and, least important, the Kill von Kull, leading from the Upper Bay to Newark Bay.

Piers and huge railroad terminals are to be found on every side, and, more important still, they line the Hudson River for four or five miles on each side from its mouth at the Battery, to Fifty-ninth Street on the Manhattan side, and to Fort Lee in New Jersey. Similarly, but to a less extent, the East River is lined with piers while a great railroad terminal is located on Long Island Sound just beyond where the East River ends. Yet thriving as it is, this great port, compared with some other great ports, is an inefficient place.

Marseilles is a smaller port than New York, yet Marseilles, for every linear foot of equipped quay, averages annually 1,500 tons of cargo transferred as against 150 at New York.

The reason for this is that the ports are two different types

In New York the piers are long and narrow and are built on piles from the shore line out into the water to the pier line. Such structures are inefficient in many ways. The piers being narrow, they make it difficult for a roadway to be kept open throughout their entire length, and force the handlers of freight to store it high on both sides. Further-



A MAP OF THE PORT OF MARSEILLES

In this case the city grew up practically without a harbour. Finally a break-water was erected parallel to the shore in order that ships might be protected from the sea.

more, the strength of the structures will seldom permit of the erection of numerous cranes along each side in order to expedite the loading and unloading of ships.

In Hamburg there are quays 1,500 feet long with 3-ton cranes spaced every 100 feet. In all of New York Harbour there is no installation similar to this. It is true that at the Bush Terminals there is an excellent installation of warehouses, piers, railroad facilities, and other port equipment—an

installation comparable to the best—but New York as a whole could be greatly improved, although it is only fair to say that the difficulties and expense would be great.

But while foreign ports are likely to be more lavishly equipped with loading and unloading machinery, it must be remembered that they, long since, have developed the small areas at their disposal and cannot readily expand, while New York, great as it is, still has room for expansion and could add many times its present equipment to what it now has.

Furthermore, New York labours under another, and a very serious, handicap. It has grown to be one of the world's great manufacturing centres. It abounds in factories. The wholesale houses, the stores, and other places of business handle huge stocks of goods, and the railroad facilities are limited. Every port should have a "belt line" railroad, that is, a railroad circling it about, crossing all the lines that come to it from any direction. With such a railroad, freight could be brought into the city by any line, turned over to the Belt Line, and switched to almost any of the industrial sections or quays. But New York has no such railroad. To begin with, New York proper is on the Island of Manhattan, and only one freight line comes into the city. The others all have their terminals in New Jersey, save for one on the north shore of Long Island Sound and one in Brooklyn. Therefore, it is necessary to transfer the freight intended for New York by means of "car ferries." Furthermore, all the freight landed on New York piers must be transported by trucks, or reëmbarked on canal boats and barges. Except on the New Jersey side of the Bay and the Hudson River, on Staten Island and at the Bush Terminals, there are few places in the entire port where railroads can run their cars to warehouses conveniently placed for the reception of cargoes.

Busy as are the piers on Manhattan Island they are de-



A TUG BOAT

The bows of these boats are often protected by pads to which much wear often gives an appearance of a tangled beard.

voted almost exclusively, so far as freight is concerned, to the shipments intended for the business houses located in Manhattan. The congestion always noticeable along West Street is due to the unfortunate location of the principal borough of New York City on an island, and little of this busy district is given over to the handling of foreign commerce.

Were the facilities for handling freight more highly developed, a large percentage of the cost of shipment would be eliminated. While the port of New York is fortunate in many respects, its plan is such that it is difficult to see how a highly efficient system of freight transfer could be installed without disproportionate expense. Lacking this system, there is a great deal of freight handled in the most expensive possible way—by hand—which could be handled more

cheaply were it practicable to instal the most highly developed mechanical assistance. This manual labour necessitates higher rates for the shipment of freight. How great these costs are is apparent when one realizes that once aboard ship, a cargo of coal could be carried from New York to Rio de Janeiro for what it would cost, to move by hand, a pile of coal the same size as the cargo, a distance of sixty feet. Such a statement gives one a little grasp on the huge costs of unnecessary freight handling.

What I have termed the "American type" of ports are those that have piers built on piles out from the shore line. Alongside these piers the ships are tied up, and largely with their own derricks they hoist their cargoes from their holds and deposit them on the pier. Sometimes these piers are two stories high, with one floor intended for incoming and the other for outgoing freight. These piers may be from a few hundred to a thousand or more feet in length, and the longer they are the broader they must be in order that there may be enough space between the freight on both sides for the trucks that cart the freight to or from them, for the longer the pier the more freight it will have and the more trucks it will need to accommodate in order to have it moved.

But piers are not the best arrangement for handling freight. A more nearly ideal arrangement is a warehouse served on one side by ships and on the other by a railroad and trucks. In this case the warehouse becomes a reservoir capable of taking quickly into storage the huge cargoes of many ships. From this reservoir of imports freight trains can be loaded conveniently without congestion. On the other hand, exports sent to the warehouse by rail can arrive in trainload or carload or even less-than-carload shipments and can be stored conveniently until a cargo is on hand, when it can quickly be put aboard ship. In such a port as New York such a warehouse would need, as well, to be equipped to

load and unload lighters and canal boats. Were all of the piers of the port of New York rebuilt along these lines—and that is practically impossible—the port could handle with ease and the minimum of expense many times its present tonnage.

What I have called the “European type” of port is one in which piers, such as those in New York, are practically unknown. Many European ports have a handicap that does not trouble ports of the United States. This handicap is the high tide. While the tide at New York has a range of $4\frac{1}{2}$ feet, at Boston $9\frac{1}{2}$ feet, at Baltimore 1 foot, Liverpool is troubled with a range of 25 or 30 feet, and many other ports have as much, or almost as much. This means that while a ship may be tied up to a pier at New York and not be bothered by an extreme movement up and down great enough



A NEW YORK HARBOUR FERRY

While these double-ended ships are large, they do not compare in size with the liners. Yet they carry hundreds of thousands of passengers to and fro across the Hudson and the Upper Bay.

to make her any difficulty in the handling of her cargo, ships in Liverpool cannot be berthed at unprotected piers, for if they were they would find their decks far below the deck of the pier at low tide, while at high tide the water would raise them until their decks would be above it.

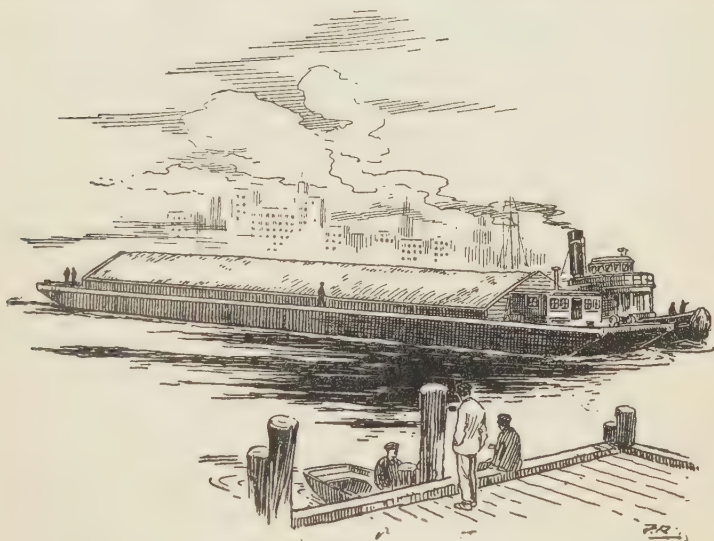
There are two ways of overcoming this difficulty. At Liverpool great landing stages are built, floating in the water parallel to the shore. Running from these to the shore are great hinged gangplanks which permit the landing stage to rise and fall with the tides while these gangplanks, which are really more like bridges, hold them parallel to the shore and serve as bridges as well. A ship, made fast to one of these landing stages, rises and falls as the stage does, and the two maintain their relative positions to each other regardless of the stage of the tide. In Liverpool these stages are largely used for passenger ships.

The other method, which is also in use at Liverpool as well as at many other ports, is to build a sea wall across the entrance to the docks, and in this sea wall to build a "lock," or a water gate. When the tide is in, the water gate is opened and the harbour or the dock is flooded to the level of high tide. As the tide recedes this lock is closed and the water level behind it remains the same. Ships pass in and out, either at high tide, when the lock or gate can be left open for a time, or, if at other stages of the tide, by means of the lock, which, being made up of two gates at the opposite ends of a long, narrow, canal-like passageway, makes it possible for the ship to pass into the lock, where the water level can be made to coincide with the level of the dock or of the water outside. Then, by opening the inner or the outer gate, as the case may be, the ship can enter the dock or the unprotected waters outside.

Equipment of both these types is to be found at a number of European ports, while still other ports, not troubled with

a great range of tide, do not find it necessary to instal them.

But the principal difference between the European and American types is to be found in the use by the former of huge quays, sometimes more or less similar in general shape to the American piers, but infinitely larger. Also they are surrounded by stone sea walls and are of dry land. On



A NEW YORK HARBOUR LIGHTER

Lighters take various forms and perform various tasks. European lighters are more likely to have pointed ends. American lighters very often have square ends. Occasionally they have engines of their own, but generally they depend on tugs for power.

these great quays are warehouses, railroad tracks, derricks, cranes, and even great railroad yards. They are of various sizes and various shapes, but all of them, by comparison with piers, are very large. At Manchester, for instance, where a harbour has been built in that inland city and connected with the Irish Sea by the Manchester Ship Canal, there are only eleven or twelve quays, but their area is 152

acres, and they have a water frontage of more than five miles. The railways and sidings on and immediately adjacent to the quays have a total length of well over thirty miles. Great warehouses, some as many as thirteen stories high, are built on these quays, with berthing space for ships on one side and railroad sidings on the other. Inland canals as well as railroads serve this port and, of course, much local freight is moved by truck. Manchester is an excellent example of what I have termed the European type of port.

But as I have said, no two ports are identical. Each port has advantages and disadvantages, problems and solutions of its own. Descriptions of a few scattered ports may be of some service in giving an idea of the variety of problems and solutions that may arise, before I turn to a description of the details of port equipment.

I have given a little space to the arrangement of the ports of New York and Manchester, and Liverpool has been mentioned. Let us turn, then, to Rio de Janeiro, a port very different from these.

Rio is on one of the most magnificent harbours in the world, and is becoming an increasingly important port. It labours, however, under a very serious handicap in that it has no waterway leading into the vast interior of Brazil. Furthermore, other easy routes inland from Rio are interfered with by the mountain ranges that lie close to the coast. Railroads have been built across these mountains for some distance into the interior, but the grades are heavy, and by present methods it would be expensive and difficult to send great quantities of freight by these routes. For this reason Rio is not likely ever to become a South American New York. Here, then, is a case of a magnificent harbour that will probably never be used to its capacity.

The harbour itself is about sixteen miles long and is from two to eleven miles in width. It is deep enough to accom-



A MISSISSIPPI RIVER STERN-WHEELER

moderate the world's greatest ships and could readily be equipped with an almost perfect arrangement of terminal facilities. As it stands the port is excellent, but by comparison with other large ports its tonnage of freight is limited. Quays similar to those so often used in European ports are in use in Rio, and in the development of the port the European system is being followed.

Capetown is less fortunate in its harbour than Rio, for Table Bay, upon which Capetown is situated, is twenty miles wide at its entrance and is fully exposed to the north and northwest gales. This handicap necessitated the construction of huge breakwaters which enclose two basins of a total area of about seventy-five acres. In addition there is a good anchorage in the lee of one of the breakwaters, and the port is expanding in order to utilize this protected spot. Here again the several miles of quays are of the European type.

Marseilles, on the other hand, can hardly be said to have a harbour at all. It is situated on an indentation of the coast

which is slightly protected by Cape Croisette, but which is entirely unprotected from the west. This has necessitated the erection of a breakwater parallel to the shore line behind which are a series of basins in which are a dozen or so docks and quays. The Mediterranean is practically tideless, so the basins at Marseilles do not require locks, but the basins, in almost every respect, except for the absence of dock gates, are similar to those, for instance, at Liverpool. A glance might suggest that Marseilles would be an inefficient port, but the contrary is the case.

I could go on almost indefinitely listing ports that differ as greatly from these as these differ from one another, but I could hardly show more clearly how diverse are the problems to be solved by the designers and builders of ports. There are many books, of which "Ports and Terminal Facilities," by Roy S. MacElwee, Ph. D., is one, that discuss the numerous economic, engineering, and structural phases of ports, and to these I refer the person interested in the technicalities of port design, construction, and operation. This outline, being consciously non-technical and limited, must pass on to other things.

What is most obvious to the casual observer at a busy port is the great and varied stream of shipping that seems for ever on the move. For a moment I shall turn to this collection of ships in order to explain the uses of the different types and the necessity for them.

A ship arrives in a busy port from a foreign country. The ship is large and is designed so as to be easily handled at sea. She is not, however, easy to handle in the restricted and crowded waters of a port. It takes a quarter- or a half-mile circle for her to turn around in, if she is under way, and she is not entirely to be trusted if the tide catches her in narrow waters. A collision may result, and so there are tugboats which, among their numerous duties, are employed to tow

her about the harbour, or to assist in turning her, or to push her awkward nose across the sweep of the tide in order that she may enter a dock or swing into a narrow slip.

Tugs are even more necessary when sailing ships appear, for a large sailing ship without auxiliary power is hard to handle in a crowded and narrow harbour. Barges, too, require outside power, which the tugs furnish, for few barges have power of their own. Canal boats are barges of a sort, and once in a port can no longer depend upon the mule teams that tow them through canals. So the tug's life is a busy and a varied one. It swings on the end of a huge hawser in its attempt to keep the *Leviathan* or the *Majestic* from sideswiping a pier. It tows barges loaded with coal, or piled high with any other kind of cargo. It tows a string



A MODERN VENETIAN CARGO BOAT

This is hardly more than a barge, with a sail plan of a modified form, somewhat suggesting the lateen rig common in the Mediterranean, and something like the lug sails common in French waters.

of empty and wall-sided canal boats up the river, or steams along with one lashed to each side. Tugs carry no cargo, but they are for ever straining at hawsers in their energetic furthering of commerce.

Lighters are of any size and of a great variety of shapes. In New York they are likely to be capable of carrying from three hundred to six hundred or seven hundred tons of freight, and are merely huge scows, their sides parallel, their ends square, their decks slightly overhanging the water at bow and stern. Often there is a small deck house for the accommodation of the "crew," which generally consists of one man, who serves as watchman, and also handles the lines as the lighter is made fast to tugs or piers or to the sides of other vessels. Other ports have other types of lighters. In Hamburg they range in size from comparatively small boats to comparatively large ones. The small ones, and even some of the larger, are often propelled along the shallow canals of the port by poles, or are pulled along the quays by men to whom lines are passed. These Hamburg lighters are often built of steel (the New York lighters are usually of wood) and have pointed bows and sometimes pointed sterns. They are broad and sturdy, some have decks, some covered decks, and some are open. In bad weather the freight on these open lighters is covered by tarpaulins. It is interesting that the largest Hamburg lighters about equal in size the smallest New York lighters. In vessels so simple as lighters are, there can be few differences save those of size and general shape, so one will find that most lighters fall into one or the other of the types I have mentioned. They are sometimes loaded directly from ships. They may be loaded from freight put ashore on piers, quays, at grain elevators and ore pockets. At some ports where the draft of water does not permit a heavily laden ship to enter, the lighters are sent out to where the ship is at anchor and

“lightens” her, if she is discharging, or takes her her cargo if she is loading. Lighters, then, are floating delivery wagons, subject to many uses.

Canal boats hardly require much space. They are merely barges whose uses are largely restricted to canals. They have no power of their own, and their journeys are generally at the end of a towline hitched to a mule or a team which walks along a tow path beside the canal. They are unbeautiful but useful, and usually have a deck house for the use of the bargeman, who is often accompanied by his wife and children. There are no masts from which to spread sails or fly signal flags, but in lieu of this, one sometimes sees the housewife hanging out her washing on a clothesline stretched wherever she can place it. In their attempt to secure the comforts of home the bargeman’s family is likely to have with it a dog or a couple of pigs, and sometimes both. Such a collection of human and animal passengers can live on a canal boat with a considerable degree of comfort, for the dangers of the sea are not for them. Although life on a canal boat is subject to some handicaps, at least it does not include danger from high seas and uncharted reefs.

The introduction of the gasoline engine has made possible successful small boats, of almost every size and shape, speedy, slow, seaworthy, or cranky, depending on their design or lack of design. They scoot everywhere on a thousand errands and add a nervous note to ports that otherwise would seem to be calm and self-possessed. These motor boats are infinite in number and are put to every use. Here, however, I shall not do more than recognize the very apparent fact that they exist.

These vessels I have named are all a port would need to take care of its overseas commerce. Most ports, however, are busy with an infinite number of other ships engaged in coastwise or inland trade. River steamers, fishermen, ferry-

boats, and coasting freighters are perhaps commoner than ocean-going ships. Then, too, one sometimes sees a floating grain elevator, not dissimilar in appearance to some grain elevators ashore. There are water barges, which supply ships with fresh water. There are dredges, seemingly for ever at work. There are glistening yachts and frowning warships. There is everything that floats rubbing elbows with everything else that floats, and yet despite the seeming confusion, the whole port is orderly, and seldom indeed are there collisions or accidents to mar the smoothness of the flow of commerce.

CHAPTER IX

THE ART OF SEAMANSHIP

SEAMANSHIP is the art of handling ships and is not to be confused with navigation, which is the mathematical science of determining ships' positions and their courses. Only sailors who have had experience at sea can be adept at seamanship, but it is quite possible for a person who has never seen a ship to learn all the intricacies of navigation. Neither is a knowledge of one requisite to the mastery of the other.

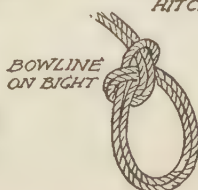
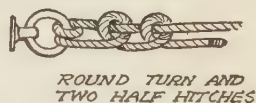
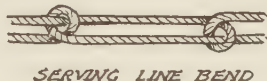
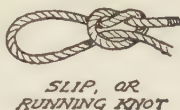
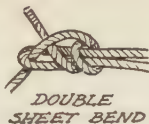
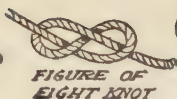
In this chapter I shall devote myself to a few of the more obvious phases of seamanship, leaving navigation for the next chapter, where I shall also touch upon piloting, a related science.

Seamanship, being an art, can be acquired only by practice, and seamen being formerly an all-but-unlettered class, jealous of their calling, wrote no textbooks of their art until Captain John Smith, the famous old adventurer in Virginia, and Sir Henry Manwayring, of the Elizabethan navy, wrote their treatises on the subject in the early part of the 17th Century. It is difficult, therefore, to say with any degree of certainty just what were the general practices of seamen of earlier times.

Because of this lack of definite information concerning ancient seamanship, I shall discuss the art only in its more modern aspects. It is interesting to mention again, however, what I have mentioned elsewhere, that the ancients were coasters rather than deep-sea sailors, who, until Columbus's

time, were unaccustomed to making long voyages out of sight of land save here and there, as, for instance, between Aden, at the mouth of the Red Sea, and India. On such a route they came and went with the monsoons, which blow alternately at different seasons of the year from and to the Indian coast. But, aside from such exceptions, the ancients, able seamen though they may sometimes have been, seldom sailed far out of sight of land. In ancient times a sailor, it would seem, was anxious to stay near shore, for then he could readily follow his route, indirect though that might be. To-day the sailor is more at ease if he is well away from land, for the perils of the deep sea are trifling by comparison with the perils of the coast. Storms at sea can usually be ridden out without danger. Storms that blow as ships approach the shore are cause for apprehension. The ancient sailor kept his eyes open for heavy weather and if he saw it coming he made straightway for the beach, and, if possible, pulled his little ship high and dry until it had passed. The sailor of to-day, too, keeps his eyes open for storms, but if they come he would rather be safely far out at sea than near the coast, unless he could ride it out in some safe harbour. These differences between the ancient and the modern seaman are due to the increase in the size and seaworthiness of ships, and to the universal use nowadays of the compass, an instrument unknown to the ancients. Nowadays, too, steam has changed things, for ships that carry, in their hulls, powerful engines capable of successfully combating the wind need fear that danger of the sea far less.

Many books on seamanship have been written since Captain John Smith and Sir Henry Manwayring published theirs. "Modern Seamanship," by Admiral Austin M. Knight, U. S. N., is a deservedly popular work, even though it is largely given over to the art in its connection with ships of war. The fact, too, that it contains 250,000 or more



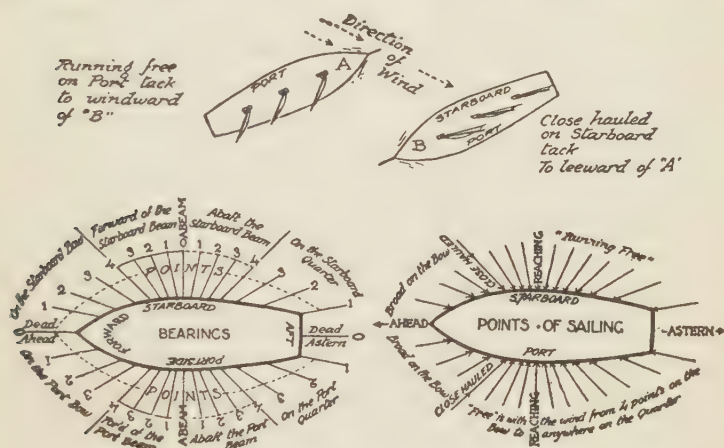
A PAGE OF KNOTS IN COMMON USE

words shows how great the subject is, and how superficial my brief discussion must be.

The first duty of a sailor is to be familiar with his ship and the apparatus he is called upon to use. In the days of the clippers every sailor had to know how to perform almost every task. Many ships of that time carried cooks, sail-makers, and carpenters, it is true, and the duties of these men were for them alone. But every sailor was likely to be called upon to reef or steer, to handle an oar in a small boat, to splice lines and tie knots of all sorts, to re-rig spars and masts, man the pumps, paint, scrub, scrape woodwork, and perform a thousand other tasks with precision and rapidity. He had sometimes to "lay aloft" and in the blackness of bitter wintry nights to find his way along the foot-rope of a swaying spar far above the deck in order to reef sleet-covered sails that whipped repeatedly from his stiffening fingers. He had to know each of a thousand lines by name so as to belay or release the right one at a moment's notice, even in the blackness of a night of storm. He had sometimes to make his way far out along the bowsprit to the jib boom or the flying jib boom in order to release some tangle of wind-whipped line, and to hold on for dear life as mountainous seas dashed their angry foam-flecked crests viciously at him as he maintained his precarious hold. He had to know what strain the whistling rigging could hold up under, and how to repair the damage wrought by storm. He had to beach his ship in far-distant ports and between the tides to scrape her bottom and calk her leaking seams. He had to know his ship from bow to stern, from truck to keel, and must ever have been ready to turn his hand to whatever task might momentarily have required him. It is no wonder that it took years to make a sailor. The wonder is that men were found to risk their lives in storm, to eat the disgusting food that such ships too often fed their

crews, to toil for months—for years—for trifling pay, beaten by their officers for minor as well as major breaches of discipline, yet willing, once a voyage was done, to spend their little savings in one wild fling and ship once more.

But most of that is gone. Sailors on the steamships that circle the earth to-day are mechanics and workmen. The man at the wheel can be taught his job passably well in a few hours. The men on deck are often not sailors at all,



BEARINGS AND POINTS OF SAILING

in the old meaning of the word, but merely labourers, who work at their appointed tasks under the direction of the officers, many of whom would be all but helpless if called upon to handle a square-rigged ship under sail.

But that is no reflection on the sailors of to-day. Their jobs are different and the wide experience and knowledge of the sailor of earlier days would benefit them little. Of what use is the ability to reef a sail to a sailor on a ship where there is nothing made of canvas save tarpaulins and awnings? Why know the intricacies of a sailing ship's complicated rigging when one comes in contact only with ships on which

the rigging is limited to steel masts and cargo booms? Why should one develop an eye for changes in the weather when a barometer can foretell it for one? Some of the old ways still leave their mark, but mechanics are of more service on the ships of to-day than sailors.

Here and there one still finds sailors comparable or even superior to the rough-and-ready men of years gone by. The fishermen of Gloucester are such men, but an able captain could more easily take a steamer across the ocean with a crew of mechanics who never before saw the sea, than with a crew of Gloucester fishermen who had had no experience with machinery. All of this was proved during the World War when Britain largely manned her M L's, those tiny motor cruisers built to hunt for submarines, with men who first went to sea in those unsteady ships of war. And America, in 1917 and 1918, sent across the Atlantic scores of craft only slightly larger—the 110-footers—most of them officered and manned with college boys and others who had had no experience at sea. And of all the scores that went over and came back in the service of the United States Navy, not one was lost because of storm or shipwreck.

But I do not mean to imply by this that the need for seamanship is gone. Far from it. Seamanship has changed, not disappeared, and more knowledge, though of a different sort, is needed to operate a steamer than to operate a sailing ship.

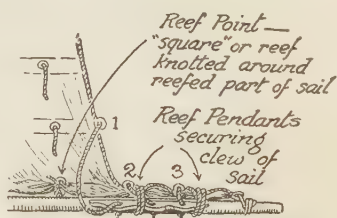
A sailor still has need to know the many knots that earlier seamen used so constantly. The square knot and the bowline are, perhaps, the most important of the lot, but the fishermen's bend and the timber hitch, the catspaw and the sheepshank, the single and double Blackwall hitches, the figure of eight, the bowline on a bight, the rolling hitch, and a dozen others are useful still. But nowadays wire rope

is commoner than formerly, so thimble eyes and wire rope clips, turnbuckles, shackles, and other apparatus used with wire rope are useful things with which to be familiar. And still it is advisable to know how to splice both hemp and wire rope. But the Turk's head, the double Matthew Walker, and others of that type are less in evidence than formerly.

More rope is used to-day in the movement of cargo than in rigging, but sailors have little to do with the cargoes of ships. Crews are used nowadays merely to handle the ships, while stevedores at every port load and unload, stow and break out the freight that fills the great holds.

Few really nautical things, in the old sense, are asked of modern sailors. They must be able to steer, although many ships have quartermasters whose duties are only those that have to do with the bridge. They must be able to handle the "ground tackle," that is, the anchors and cables, but that is simple, for one has only to throw off a few lashings and pull a lever in order that the anchor may plunge to the bottom as the cable roars through the hawse pipe. To weigh anchor a steam valve is opened, or an electric switch is turned, and a windlass brings in link after link until the anchor once more is snugly in place, while the hawse pipe drips water and the anchor flukes drip mud. The sailor then has only to wash the mud from the flukes with a hose, clamp down a "slip stopper" to make the cable secure, and the task is done.

Sailors are supposed to know how to lower and handle the lifeboats, and many of them do, but alas, the smartness of



HOW A FORE-AND-AFT SAIL IS REEFED

The sail is partly lowered, the reef points are tied beneath the sail and above the boom, and the sail is then raised. A part of the sail, however, has been held by the reef points and is not spread to the wind.

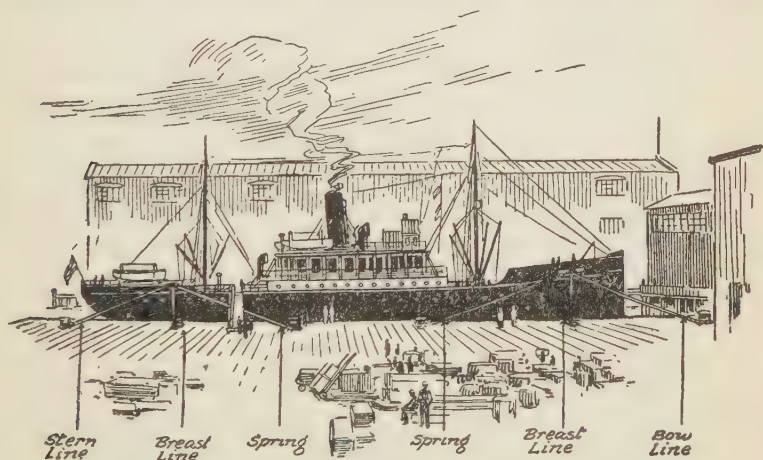
small boats under oars is almost gone. Such a thing takes practice and coördination, and few indeed are the merchant ships to-day that can muster a boat crew worthy of the name. And even that is less necessary than it was, for motor boats do the work in ports, and lifeboats need only float for a time before they are picked up by some ship that has caught the radio call for help. And to float they need no seamen, for nowadays they are both noncapsizable and practically unsinkable.

If a ship goes aground where there is no help, the old method of using small boats to carry an anchor out to seaward and of hauling the ship off by means of a cable made fast to the anchor, is seldom enough in these days of large ships to accomplish the task. The unfortunate ship is either beyond help, save for her crew, or needs a sea-going tug or two and a crew of professional salvagers.

And so I could go on through many more phases of seamanship, proving that the knowledge required of deck hands is less than formerly. But the knowledge required of officers is another matter.

Officers must know an infinite number of things that a deck hand need not trouble himself to learn. They must know how to manœuvre to avoid collision, an important matter in these days of many ships and busy sea lanes. They must know the rules of the road, for every ship one passes close to must be signalled in order that her officers may know exactly what the approaching ship is planning to do. An officer must know a hundred different arrangements of lights at night, which may mark ships under sail, under power, at anchor, with barges in tow, ships not under command, buoys, lighthouses, cable vessels, pilot ships, fishermen with their gear drifting about them, open boats, and a variety of other things. He should be able to signal in the International Code with a flashlight. He must know

how to handle his ship in heavy weather in order that her hull shall not be unduly strained, her upper works unduly battered, or her cargo shifted. He should be adept at handling his ship around a dock, and must be equally adept at making her fast alongside pier or quay. He must know what to do in case of collision, in case of fire, in case any of a score of contingencies arise. He must be familiar with first aid and the use of medicines, for few ships carry doctors. He must be seaman enough for all his crew, for on him rests a great responsibility—the responsibility for a great and costly machine, for valuable cargoes, for the health, and even for the lives, of many men. Should a man ashore be employed to manage a factory as costly as a ten-thousand-ton ship, with an output as valuable as the cargoes of such a ship, he would be paid many times what a captain is paid, and, should fire destroy his factory or tornado crush it, he



A FREIGHTER TIED UP TO A PIER

The lines shown running from the ship to the pier are often used in slightly different arrangements, but always it is advisable to run lines diagonally in order that slight movements of the ship away from the pier may be checked gradually and without breaking the lines. Furthermore, this arrangement prevents movement ahead or astern.

would probably be given the insurance money in order to build another. Not so the captain. His responsibility is as great or greater; his experience and ability must be at least as great; his pay is little; and should a tempest tear his ship apart beneath him he is likely to be doomed for ever after to stay ashore, a broken captain, and probably a broken-hearted man.

The captain of a sailing ship must be familiar with many things that the captain of a steamer need not know. As in practically every other line of modern endeavour, the handling of ships has developed specialists. The chief engineer is responsible for the motive power of ships to-day. And he need know nothing more than how to operate the machinery. The captain need only know, so far as power is concerned, whether he wants the propeller to drive him ahead or astern and how fast, and how to use his propellers in tight places. The argument as to who is more important to the ship, despite its futility, still sometimes waxes strong. Both are essential, for the engineer harnesses the steam that drives the ship. He must be subject to the commands of the captain, who formerly had need himself to know how to harness power by means of sails, which were his engines.

To a traveller unfamiliar with ships the captain of a steamer seems generally to have an easy job. The mates stand the watches on the bridge, the engineers below, and often a captain is actively engaged in handling his ship only in leaving and arriving at ports. For the remainder of his time at sea he reads or paces the deck, takes his meals regularly, and does little else save make observations with his sextant in the morning, at noon, and in the afternoon, spending at this task hardly more than a few minutes each day. These are his activities during fine weather, which, fortunately, is most of the time. If fog and storm intervene, the story is a different one, and every captain finds it neces-



SHIP



BARK



BARKENTINE



BRIG



BRIGANTINE



HERMAPHRODITE BRIG



TOPSAIL SCHOONER



SCHOONER



KETCH



YAWL



CUTTER



SLOOP



LUGGER



SLIDING GUNTER

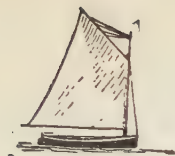
A FEW TYPES OF SAILING SHIPS COMMON IN EUROPEAN AND AMERICAN WATERS

sary, at times, to spend whole days and nights on the bridge, his food brought to him, his every sense alert to take advantage of each opportunity the elements present to ease his ship, to keep her on her course, to watch, if land is near, lest breakers and black rocks should be his port of call.

Nor should a captain content himself with knowing how to handle his ship in heavy weather. A knowledge of the causes and actions of storms is highly important. From a barometer much can be deduced about changes in the weather, and if one knows what to expect he is likely better to be able to meet it.

I said that a man could be taught to steer passably well in a few hours, and that is true *at sea*. But the steering of a ship amounts to more than holding her to her course across wide stretches of smooth water. Many a ship has been saved from collision because her officers knew accurately her "turning circle," her "pivoting point," her "kick," and other fine points of her steering. It could readily happen if two ships were approaching each other "bow on" that they could safely pass if each put her rudder half over to the right, and that their sterns or even their sides would collide if each put her rudder full over to the right. Such a thing is due to the fact that ships steer with their sterns. To change a ship's direction to the right the rudder moves her stern to the left. It is as if an automobile were being backed. To turn a corner its hind wheels would not change their course until the front wheels had been swung sharply to one side.

Then, too, ships steer differently in shallow water than in deep. Sometimes a ship which, at sea, is responsive to the lightest shift of her rudder will behave like mad in a shallow channel. This is due to the shape of the hull and the paths followed by the displaced water as it flows past her sides and beneath her keel. In shallow water, the water that normally would flow beneath her cannot all do so, and the result is



CATBOAT



DHOW



CHINESE JUNK



NORWEGIAN JAEGT



RUSSIAN SHIP



NORWEGIAN SHIP



DUTCH SCHUYT



ENGLISH BAWLEY



THAMES BARGE



NORFOLK WHERRY



FRENCH CHASSE-MARÉE



SCOTCH ZULU



PENZANCE LUGGER



MEDITERRANEAN FELUCCA



INDIAN SAMPAN

A FEW TYPES OF SAILING BOATS TO BE FOUND AROUND THE WORLD

likely to be a difference in the way she answers her helm. For other reasons a ship must not be driven too rapidly through a shallow channel. I once saw a ship drawing seventeen feet ground sharply in the eighteen-foot channel leading into St. George, Bermuda, for at the speed she was making she was pushing a part of the water ahead of her and lowering the water level of the channel by more than a foot. Ships running on parallel courses at a considerable speed should not permit their courses to be too close, else a similar thing might happen, bringing them forcibly together. This happened to the *Olympic* and a British cruiser years ago in the English Channel.

These are only a few of the many things that might arise in handling ships. Other possible contingencies are almost infinite in number. Furthermore, it is the experience of sailors that no two ships, no matter how nearly they may be alike, are identical in their actions. This belief (and it has a very great deal of truth behind it) has probably had more than a little to do with the habit, that seems natural to seamen, of personifying ships. In addition to the fact that all ships have characteristic ways of their own, most ships react differently under different conditions of loading and when carrying their varying cargoes. A tramp loaded with iron ore will sometimes be uncomfortable in heavy weather even though she may be thoroughly comfortable in a similar storm when loaded with coal. The reason for this lies in the fact that iron ore, being heavy, loads a ship to her Plimsoll mark without filling her holds. Thus the heavy cargo gives the ship a low "centre of gravity" and she may roll heavily and constantly. Coal, on the other hand, is lighter than ore, and a cargo fills her hold to overflowing, raising her centre of gravity and reducing the roll. The captain, however, must know just how his ship handles whether she is carrying ore, or coal, or any of a score of different cargoes.

Let us take an imaginary voyage on a ship in order to see what seamanship is required of her officers and crew. Suppose we board a ship of 3,500 tons, loaded with coal, at Philadelphia, bound for Havana. The voyage is short, but a variety of conditions of weather and of climate will be contended with and the voyage will be a test of seamanship. Remember, however, that such a ship is far different from ships intended for passengers. Heavy weather will dash waves across her decks when the decks of passenger ships will remain entirely dry. This ship was not built for passengers and her decks are low and are unprotected from the sea.

The ship casts off from the pier above the city with the first mate in command, the captain being still ashore attending to the requirements laid down by law and seeing his owners. The tide being slack, and the currents temporarily stilled, a tug is not called. The steamer is lying with her stern to the river and with her starboard or right side next the pier. Six lines make her fast: a line leading from the starboard bow well up the dock—the bow line; a line leading from the same pair of “bits” directly to the dock—the bow breast line; a third line from about the same point at the bow, along the pier for a distance toward the stern—the bow spring. From “bits” on the starboard quarter—that is, at the right side, a little forward of the stern—three other lines are led similarly to the pier, and are named stern spring, stern breast, and stern lines, the last reaching as far astern as the bow line reaches ahead.

The lines, except for the bow spring, are cast off, and with this one line still fast from the bow aft along the pier, the mate orders the helmsman to throw his helm hard over to port. This brings the rudder to starboard, that is, toward the dock, and when the mate signals the engine room for “slow speed ahead” the stream of water from the propeller

against the rudder swings the stern slowly away from the pier for the line from the bow to the pier does not permit the ship to forge ahead. When the stern is well clear of the pier the mate signals "stop" to the engine room, orders the last line thrown off, the helm amidships, that is, neither to the right nor to the left, signals "slow speed astern," and the ship slowly backs out of the slip. As she slides clear of the end of the pier the helm is put over to port once more, the stern swings gradually upstream, and as the bow swings around parallel to the shore the helm is again brought amidships, the engines are stopped and then signalled for "slow speed ahead" once more, and the voyage is begun.

As the ship loafs slowly down past the foot of Market Street a tug puffs up alongside, our captain steps from its bow to the rail of our ship, for we are deeply laden, and the lowest sections of our decks are hardly more than four feet above water, waves to the skipper of the tug, mounts to the bridge, speaks to the mate, orders "half speed ahead," and we steam sedately through the ferry lanes and gradually leave the busy section of the river behind.

Usually a pilot is aboard, but sometimes port rules permit captains to take their own ships out, and with an American ship loaded with coal out of Philadelphia that is the case, saving the owners the expense of the pilot. So our captain, sitting on a high office stool, which looks very much out of place on the bridge, takes us down the river, turning here and there as he makes out the buoys, which are red and conical to port and black and cylindrical to starboard as we leave the port.

As the deeper water of Delaware Bay is reached the speed is increased to its maximum, which is only about nine knots an hour, and the captain, after hours on the bridge, is relieved by the first mate and goes below.

The ship, having been loaded with coal, at a "coal pocket,"

where tons and tons have roared down into her holds through great chutes, is covered with a thick layer of coal dust, and looks like an unfit habitation for men. The deck hands are set to work cleaning the deck amidships, but one wonders if the ship will ever be clean again. And then the first of the swells from the Atlantic raises her bow gently. Another follows and another, and then one climbs straight over the blunt bow, cascades over the forecandle, and one begins to realize that the tumbling waves are already at work cleaning the dust from the grimy ship.

Dusk has fallen, and the Fourteen-Foot-Bank Lighthouse and the one on Cape May gleam mysteriously, and as darkness hides the restless sea the lights still gleam. A steamer passes us, her running lights and range lights clear green and red and white, and then we are alone, bound outward to the heaving bosom of the great Atlantic. The light on Cape May fades from sight, and only the fading ray from the Fourteen-Foot-Bank Lighthouse is left to bind us to the busy world of North America—and finally that, too, is gone, and we are alone upon the dark and pathless sea beneath a clouded sky, dependent for our directions upon a swaying compass card lighted by a dim lamp mounted in the side of the brass binnacle.

As we passed the Fourteen-Foot-Bank Lighthouse, and were able accurately to check our position on the chart, the log, a sort of nautical odometer that tells with a fair degree of accuracy the mileage travelled, was set in motion by heaving the rotator over the stern at the end of the log line. This rotator, set in motion by the passage of the water, twists the line to which it is attached, and the line, in turn, rotates the mechanism that records the mileage. It is very similar to the speedometer on the dash of the automobile except that it shows only the mileage.

If we visit the bridge we may learn from the mate on duty

that the barometer has fallen a little, and that we probably will have a touch of heavy weather by morning.

We turn in in a comfortable stateroom situated in the deck house just aft the bridge, and, leaving the port open, for ventilation, go almost instantly to sleep, forgetful of the man at the wheel, who stands with his eyes fixed on the slightly moving compass card, turning the wheel first this way and then that, absolutely confident in the unerring compass.

Outside, pacing back and forth on the bridge, is a mate, who went on watch at eight and will be relieved at twelve. As he leans over the port rail for a moment, the red rays from the port running light palely illuminate his tanned face. He is confident of his ship, confident of the engineers and firemen below, confident of the man at the wheel, and is calm and contented.

During the next seven or eight hours the storm gradually approaches. Higher and higher roll the waves, deeper and deeper rolls the ship, and suddenly we are aroused by the crash of a sea that mounts the side, dashes across the deck, and pours in a great stream through our open port. Shocked instantly into consciousness we leap from our bunks, into the inch or two of water that is swishing about the stateroom, and close the port, just too late to save ourselves from a wetting. But our interest is aroused by the dull gray sea, the rising and falling waves, the driving spray, and, quickly dressing, we hurry out on deck and up to the bridge, fearful, perhaps, that trouble is at hand. But once on the bridge everyone is calm—no one is worried. Another mate, now on duty, sings out a cheery "Good morning"; the man at the wheel looks up, nods, and drops his eyes once more to the compass card. We tell of our wetting and are laughed at, and the ships goes rolling and pitching on, the waves piling one after another over her weather rail, filling the low deck forward of the bridge, gurgling around the hatches,

and finally pouring back into the sea in cascades through the scuppers. Now and again the combination of the ship's roll and an advancing wave forces a great foamy cloud high over



THE RIGGING OF A THREE-MASTED SHIP

(1) Foremast; (2) Mainmast; (3) Mizzenmast; (4) Fore, main, and mizzen-topmasts; (5) Fore, main, and mizzen topgallant masts; (6) Fore, main, and mizzen royal and skysail masts; (7) Fore yard; (8) Main yard; (9) Crossjack yard; (10) Fore, main, and mizzen lower topsail yards; (11) Fore, main, and mizzen upper topsail yards; (12) Fore, main, and mizzen lower topgallant yards; (13) Fore, main, and mizzen upper topgallant yards; (14) Fore, main, and mizzen royal yards; (15) Fore, main, and mizzen skysail yards; (16) Spanker gaff; (17) Fore and main trysail gaffs; (18) Lower shrouds; (19) Topmast shrouds; (20) Back stays; (21) Fore skysail stay; (22) Fore royal stay; (23) Flying jib stay; (24) Fore topgallant stay; (25) Jib stay; (26) Fore topmast stays; (27) Fore stays; (28) Main skysail stay; (29) Main topgallant stay; (30) Main topmast stay; (31) Mizzen skysail stay; (32) Fore and main lifts; (33) Topsail lifts; (34) Topgallant lifts; (35) Spanker boom; (36) Bowsprit; (37) Jib boom; (38) Flying jib-boom; (39) Martingale or dolphin striker; (40) Braces (named from the yard to which they are attached); (41) Bobstays; (42) Martingale stays.

the bow, where the spray is caught by the wind which whistles aft with it, stinging our faces and leaving a pleasant taste of salt upon our lips.

The sky is still overcast, and as eight o'clock comes the clouds grow heavier, if anything, making it impossible for the officers to take the elevation of the sun with their sextants in order to work out our position. But the record of the log is taken, a line is drawn from our "point of departure" off Cape May, drawn at the angle from that point that our helmsmen have been steering, and the distance we have run—92 miles, since the evening before—is marked on that line, giving us our position according to dead reckoning.

Our course has been south, and so, while in the position we have there may be an error of two or three miles marked, we know that we are not far wrong, and that we are safely out at sea, about fifty miles due east of Cape Charles, which is at the entrance to Chesapeake Bay.

The captain now has a decision to make: The action of the barometer suggests that heavy weather will continue for a while—which is not surprising, for we are approaching Cape Hatteras, where storms are perennial. If the sky remains overcast we will not be able to get a glimpse of the sun, and consequently will not be able to work out our position, and dead reckoning, while accurate enough for short runs, is liable to grow progressively inaccurate if the run is long. In addition to all this we must either change our course to the east in order to cross the Gulf Stream, or a little to the west in order to stay between it and the coast, for it is wasted effort to go against a strong current when it isn't necessary. Even if we cross the Gulf Stream to its outer edge we may have to go for several days without a sight of the sun. If we stay inside it we probably won't see the sun any sooner, but we can pass close to Diamond Shoal Lightship, which lies off Cape Hatteras, and so check up our position.

The captain decides for this latter course, after studying the barometer again and deciding that the chance for more violent weather is slight, and with a mark on the chart for

our position at 8 A.M. the course is changed slightly to the west of south.

All day we roll and pitch, not badly, but very steadily, but from the calmness of everyone about us we, too, view the gale as of no great importance. Nor is it, for, while the wind is kicking up a rough sea, the waves are far from mountainous, and in our deeply laden condition almost anything more than a ripple would wash over our low forward deck.

We have our meals and return after each one to the bridge—always the most interesting place on a ship, particularly in heavy weather—but by the time darkness has returned we have seen nothing on the gray and “smoky” sea save, in the distance, a steamer, that has been lost to view again, and a schooner under double-reefed sails that passed us bound north during the afternoon.

We are ready to turn in early, for all day on the bridge with the spray-laden wind blowing strongly in our faces has been tiring. We leave word to be called when Diamond Shoal Lightship is sighted, and roll into our bunks.

At four-thirty in the morning we are called, and bundling ourselves into our clothes we stumble out on deck. The wind has increased, and sweeps back from the bow furiously and heavy with moisture. The ship is rolling deeply, and ever and anon a huge wave pounds heavily on the high steel bow.

Up on the bridge the captain is pacing in his oilskins, and with him is the mate, but the night is dark and we stumble against them ere our unaccustomed eyes can make them out.

“She’s blowing a bit,” shouts the captain, and we silently agree to his very obvious remark.

“Have you picked up Diamond Shoal Lightship?” we shout in return.

“There it is,” he replies, “two points off the starboard bow.”

But search as we will in the blackness ahead we cannot

make it out, until, our eyes having become more accustomed to the darkness, it shows up like a pin prick in a black curtain, showing now and then, and lost to sight as much as it is visible.

The gale has grown stronger and is almost from dead ahead, while the huge waves cascade over the forecastle, roaring and tumbling—gray with phosphorescence in the darkness.

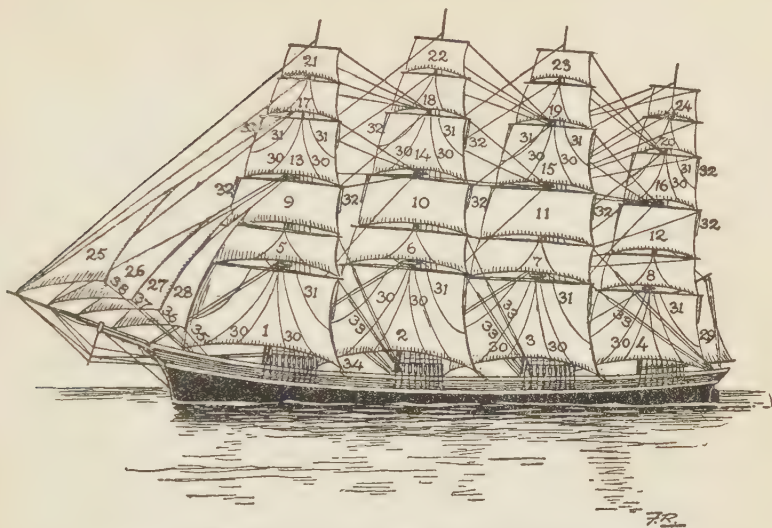
The eastern sky pales slowly, and gradually the morning comes, ghostly and without colour. The sky is gray, the sea is gray, flecked everywhere with white, and nothing is in sight as daylight comes. The lightship is invisible, and everywhere about us is the tumbling water.

We go below and have breakfast from a table on which the racks are placed to keep the dishes from crashing to the deck. We return to the bridge, and still the lightship is not visible. Have we passed it? No, we learn. For the last four hours we have made, perhaps, two miles, for a heavily laden freighter capable of only nine knots at the best is not able to make much headway against the current and such a gale off Hatteras.

By noon the lightship can be seen intermittently in its waste of boiling sea, and all afternoon we can see it occasionally as it slowly passes astern. But we have checked our position from it and have a new "point of departure" from which to lay our course for the south.

During the evening the captain tells us that the barometer has risen somewhat and that we may look for fine weather in the morning. We turn in, hoping for fine weather, but glad to have been through a Cape Hatteras blow.

And in the morning we look out through our port on to a summer sea. A swell is running, it is true, and the ship still rolls, but the sky is blue, the sea is blue, and a school of porpoises are leaping gaily from the water alongside.



THE SAILS OF A FOUR-MASTED SHIP

(1) *Foresail*; (2) *Mainsail*; (3) *Crossjack*; (4) *Jigger*; (5) *Lower foretop-sail*; (6) *Lower main topsail*; (7) *Lower mizzen topsail*; (8) *Lower jigger topsail*; (9) *Upper fore topsail*; (10) *Upper main topsail*; (11) *Upper mizzen topsail*; (12) *Upper jigger topsail*; (13) *Fore topgallant sail*; (14) *Main topgallant sail*; (15) *Mizzen topgallant sail*; (16) *Jigger topgallant sail*; (17) *Fore royal*; (18) *Main royal*; (19) *Mizzen royal*; (20) *Jigger royal*; (21) *Fore skysail*; (22) *Main skysail*; (23) *Mizzen skysail*; (24) *Jigger skysail*; (25) *Flying jib*; (26) *Outer jib*; (27) *Jib*; (28) *Fore topmast staysail*; (29) *Spanker*; (30) *Buntlines*; (31) *Leechlines*; (32) *Reef tackles*; (33) *Braces*; (34) *Fore-sheet*; (35) *Fore topmast staysail sheet*; (36) *Jib-sheet*; (37) *Outer jib-sheet*; (38) *Flying jib-sheet*.

Our course has been changed to southwest, and after breakfast the captain and his mates take the sun's altitude, work out our longitude, and compare notes. At noon our latitude is worked out, and about four o'clock our longitude again.

On the evening of the third day we check our position again when Cape Canaveral is picked up. The next afternoon we pass Palm Beach, with its hotels and bathers plainly visible as we hug the shore in order to keep away from the strong current of the Gulf Stream. We follow the curve

of the Florida coast and the Florida Keys for another twenty-four hours, and then strike across the dark blue water of the Gulf Stream for Havana.

When we appear on deck the next morning we learn that, having reached the Cuban coast while it was still dark, we have been forced to lie to until daylight should bring the pilot boat out.

Finally the pilot appears and the ship heads for the narrow harbour entrance. A triangular pennant, which from its appearance might have been cut from an American flag, flies on a staff on Morro Castle, signalling the arrival of an American merchant ship. A motor boat comes up alongside and a port doctor comes aboard. We are all lined up while he looks us over hurriedly, signs his report, and leaves. The ship has made her way slowly into the little harbour, and finally her engines are stopped, her anchor is let go, and with the roar of the cable through the hawse pipe the voyage is ended.

Such a voyage as this is not unique. Thousands of ships on thousands of routes go through similar experiences. Whole voyages are often taken without a hint of storm. Whole voyages, again, are taken through continuous and unending storm. Ships sometimes come into Halifax or Boston caked with ice—their rigging inches thick with it, their bulwarks buried. Again, typhoons drive ships upon dark rocks, or overladen ships capsize because of storm. But consider the thousands that sail the sea—consider the fact that not a storm can blow across the great stretches of the unfrozen seas without engulfing many ships within its mighty grasp. Yet with all this one rarely reads of shipwreck—there are few ships that find their ends in storm.

And this is because men build ships sturdily and handle them adeptly. Their art is seamanship, and after all, they are artists.

CHAPTER X

THE SCIENCE OF NAVIGATION

NAVIGATION, I may be permitted to repeat, is the mathematical science of finding ships' positions at sea and of laying down courses to be followed. For the designation of positions latitude and longitude are used, latitude being measured north and south from the equator to the north and south poles, the equator being zero degrees of latitude, the poles being ninety degrees north and ninety degrees south latitude. Longitude is measured from zero degrees to 180 degrees east and west from the meridian running from the North Pole to the South through Greenwich, England, 180 degrees east longitude marking the same meridian as 180 degrees west longitude. For instance, Three Kings Island, the tiny island which is the northernmost land of the New Zealand group, is located as follows: Latitude 34° South; Longitude 172° East. This means that this island is 34 degrees south of the equator and 172 degrees east of the meridian of Greenwich. Actually navigation is a problem in spherical trigonometry and astronomy, depending principally, nowadays, upon an instrument called a sextant, which is used to measure the altitude above the horizon of a celestial body (sun, moon, or stars), and upon a very accurate timepiece, called a chronometer, which shows the time of a given meridian—generally the meridian of Greenwich, England.

In practice, however, it is necessary to know no mathematics other than arithmetic, for the formulas have been simplified and handbooks have been compiled which elimi-

nate any necessity for the practical navigator to delve into the intricacies of spherical trigonometry, a subject that would frighten most sea captains more than all the other perils of the deep.

There is another but less accurate method, called "dead reckoning," which is used in connection with the more accurate science, and is used by itself when clouds obscure the sky or fogs hide the horizon. When land is in sight both these methods largely or entirely give way to "piloting," which makes possible the accurate finding of a ship's position by reference to known objects ashore.

I shall not attempt to explain all the intricacies of navigation, for even a simplified complete explanation would in itself become a small book. There are many books on navigation. Nathaniel Bowditch's exhaustive treatises have been revised many times and the whole compilation is kept up to date so that, while Bowditch himself died in 1838, the book bearing his name, and still referred to almost universally as "Bowditch," is accepted as a peerless authority. But it is a huge tome, and other practical books, such as "Elements of Navigation," by W. J. Henderson, are available for the person who wishes to profit by a simpler, if less exhaustive, explanation. To these two books, and to a dozen others, I refer the interested reader anxious to learn what, after all, is beyond the range of this outline.

Up to the 15th Century the science of navigation was unknown. Before that time mariners occasionally ventured out of sight of land, for short passages during which, because they had no compasses, they attempted to guide themselves by reference to the sun or stars. When clouds obscured the sky, however, they usually lost their direction, and even when the sky was clear they knew no way of ascertaining anything more than rough approximations of the cardinal points.

It seems just a bit strange that sailors were so backward in developing means of determining their positions at sea by reference to the sun and stars, while even the ancients were fairly accurate in their ability to locate their positions ashore by such methods. This undoubtedly was as much due to the lack of general knowledge among sailors as it was to the unsteadiness of the ships themselves which made it difficult for careful astronomical observations to be made. But whatever the reason, the fact remains that it was not until after the introduction of the compass that navigation began to make its first faltering advances.

That this beginning was made during the period in which



USING A CROSS STAFF

This crude instrument was used in an attempt to work out problems in latitude. After holding one end of the staff to the eye and sliding the cross staff along until the observer sighted over one end at the sun and under the other at the horizon, the instrument was placed on a circle marked in degrees, and the angle was determined.

Portugal expanded her commerce only goes again to show that the application of new minds to old problems results, almost invariably, in progress.

Columbus, of course, did not begin the era of discovery. Prince Henry, the "navigator," sent out an expedition from Portugal in 1432 which rediscovered the Azores—an astonishing thing for times so early, for the Azores lie 830 miles west of Portugal and are farther from a continental mainland than any other of the islands of the Atlantic. That the islands were known to the ancients, however, is proved by numerous Carthaginian coins found on the island of Corvo, but their location and practically everything else concerning them seems to have been lost until Henry the Navigator attached them to Portugal.

But the rediscovery of the Azores proves only that the sailors put great faith in their compasses, and sailed, despite their fears, out to the west where all of them *knew* (it was no matter of mere *belief*) that the sea ended somewhere suddenly, and that their cockleshell ships would, if they but sailed to the edge, fall down the smooth green cataract of an awful, endless waterfall, into limitless space, or, mayhap, to the vast foundations upon which the world was built. To them it was as if a canoe were being paddled downstream to the brink of a cataract to which Niagara itself would be but a raindrop falling from the eaves.

At the time of the rediscovery of the Azores navigation was, with the exception of the compass, without any of the instruments that later came into use. Prince Henry, however, realizing the importance of compiling information useful to mariners, systematized all the information available and erected an observatory to determine more accurately the data in reference to the declination of the sun.

Most navigators use the sun far more than any of the other celestial bodies in order to determine their positions, and

the first thing necessary is to know its declination—that is, its distance north or south of the equator.

During the course of a year the movement of the earth, with its axis inclined at an angle to the plane in which it moves about the sun, brings the sun vertically over every section of the earth from twenty-three and one half degrees north of the equator to twenty-three and one half degrees south and back again.

During the year, then, the sun is twice directly over our equator. Suppose at noon on one of these days a mariner wishes to determine his latitude, that is, his distance in degrees, minutes, and seconds north or south of the equator. He measures, with his sextant, the angle between the sun and the horizon. If he were on the equator that angle would be ninety degrees, for the sun would be directly over his head. He would then subtract the angle shown by his sextant from ninety, the number of degrees between the horizon and the zenith. In this case the answer would be zero. Therefore his latitude would be 0 degrees, and that is on the equator. If he were at the North Pole or the South, the sun would be on the horizon, and his sextant would show an angle of 0 degrees. Subtracting this from ninety he would find his latitude to be ninety degrees, north or south of the equator, as the case might be. At any position between the equator and the poles the problem would be worked in the same manner.

But, except for two days in the year—but for two moments I might almost say—the sun is never directly over the equator, and declination is its distance at any given time north or south of the equator, measured in degrees, minutes, and seconds. This cannot be learned by any observations from a ship at sea. It is comparatively simple, however, to learn it by careful studies made at well-equipped observatories, and the results of these studies are now furnished mariners

in carefully compiled form, so that they have merely to turn to their book in order to learn what the sun's declination is at any given time.

It was this work that Prince Henry began, and modern navigation may, perhaps, be said to have begun with his studies.

But all the tables of declination are of no use without an instrument with which to measure accurately the angle between the sun and the horizon, and such an instrument was slow in coming. The first apparatus used was called a "cross staff." It was made of two rods, one about thirty-six inches and the other about twenty-six inches long. The shorter staff was arranged so that its centre slid along the other while it remained rigidly at right angles to the longer staff. To work out one's latitude with this instrument the observer waited until noon was almost upon him. He then took his cross staff and, placing one end of the longer crossbar to his eye and holding the instrument so that the shorter bar stood in a vertical plane, moved the shorter bar back and forth until he could sight over the upper end at the sun and, at the same time, beneath the lower end at the horizon. As the sun continued to mount to its highest point he pulled the cross staff slowly toward him, measuring a greater and a greater angle. When the sun had reached its highest point and the angle between it and the horizon began to lessen, his "sight" was completed, and carefully holding the crossbar where it marked the greatest angle he laid it on a table on which a circle was inscribed. The end that had been at his eye he placed at the centre of the circle, and the segment marked by the lines from the centre past the two ends of the crossbar showed the number of degrees in the angle he had measured between the horizon and the sun.

But any one who has attempted to sight a gun accurately while standing on an irregularly moving platform will have

some idea of the difficulty these old sailors had in sighting accurately at the horizon and the sun at identically the same time from the deck of a bobbing ship. The glare of the sun, the motion of the ship, and the inaccuracy of the instrument itself could not be expected to give more than approximate



USING AN ASTROLABE

This instrument was meant to improve on the cross staff. One man held it, when it was supposed to hang with the horizon line horizontal. Another man sighted at the sun or the stars, and a third read and recorded the angle. Needless to say the instrument was very inaccurate.

results, especially as the several corrections on the angle now known to be necessary (the refraction of the sun's rays as they enter our atmosphere is one) were either not recognized or were inaccurately known.

Later the "astrolabe," an instrument almost equally crude, was introduced. It was made of a heavy tin or bronze plate, circular in shape, and pivoted to its centre was a bar running across it from side to side. It was marked in de-

grees and fractions, and while one man held it, as steadily as he could, a second sighted along the pivoted crossbar and a third read the angles. Vasco da Gama used one of these in 1497 on his voyage around the Cape of Good Hope, but it did not turn out to be much of an improvement on the cross staff.

But up to this time, and even later, the science of navigation consisted almost solely of the approximate determination of latitude and mere guesses, based on the estimated speed and direction of the ship through the water, for longitude. So hopeless did it seem at that time for mariners scientifically to determine their longitude that an old writer on the subject is quoted by the *Encyclopædia Britannica* as saying, "Now there be some that are very inquisitive to have a way to get the longitude, but that is too tedious for seamen, since it requireth the deep knowledge of astronomy, wherefore I would not have any man think that the longitude is to be found at sea by any instrument; so let no seamen trouble themselves with any such rule, but (according to their accustomed manner) let them keep a perfect account and reckoning of the way of their ship."

These early sailors learned, of course, that their latitude could be worked out by observing the North Star, and they used that method, crudely, of course, but similarly to the way it is used to-day. For this a contrivance called a "nocturnal" was adopted. With this they could determine what position the North Star was in, in reference to the true pole, for, of course, the North Star does not exactly mark the pole, but revolves about it in a small circle.

While the voyage of Columbus did not actually begin the era of discovery, it did greatly increase interest in exploration, and as most of this exploration necessitated long ocean voyages the interest in navigation grew apace. One of the earliest writers on navigation was a man named John Werner.

In 1514 he explained the use of the cross staff, which for many years had been used on shore but had been first utilized at sea not very many years before Werner wrote. A little later one R. Gemma Frisius wrote a book which contained a great deal of information useful to men of the sea. In it he described the sphere with its parallels of latitude and its meridians of longitude much as we use them to-day. Up to this time, however, no agreement had been made upon what meridian to base the measurement of longitude. Nowadays the meridian of Greenwich is used. Frisius, however, suggested the meridian of the Azores. Any meridian, of course, would do, provided that the necessary data be based upon it, but the data available in the early 16th Century were slight indeed.

The necessity for drawing curved lines on flat charts to represent the courses of their ships now began to be understood, for ships do not sail on a flat surface but instead sail on the ever-curving surface of the sea. To the person accustomed, as most of us are, to looking at maps printed on flat pages, this truth becomes evident when he draws a straight line on a flat map, and then transfers the line to a geographical globe, making it pass through the same points.

Mariners were troubled, too, by the difficulty of accurately and easily drawing parallel lines on their charts, but this was overcome in 1584 when "parallel rulers" were first used by one Mordente. "Parallel rulers," which are nothing more than two rulers hinged together so that whether they touch each other or are separated they remain parallel, are a part of every navigator's equipment to-day.

Tables of the tides began to appear in the latter part of the 16th Century, but they were woefully inaccurate, and other information, while increasing, still was liable to be seriously in error.

Even points ashore, where observations could be worked

out under the best possible conditions, were thought to be from a few minutes to several degrees from what we now know are their positions, and when one realizes that an error of one minute of latitude means an error of one mile, it will be seen that an error of fifteen or twenty minutes might be enough to put a ship in grave danger while her captain thought her safe, and that a position in which there is an error of several degrees is little more than worthless, for each degree of latitude represents 60 miles, and three or four degrees mean one hundred and eighty or two hundred and forty miles. When it is realized, furthermore, that such errors as these were made ashore, where the observations were much more accurate than they could be at sea, one understands why seamen trusted their navigation but little, for they were often faced, no doubt, with errors of three or four hundred miles. And, if anything, their methods of determining latitude were less inaccurate than those used in determining longitude. Truly, navigation in those days left much to be desired.

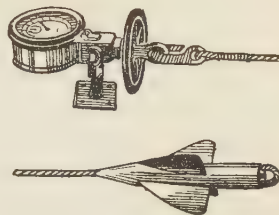
Other instruments were invented from time to time in the struggle to master navigation. The "astronomical ring" was one, but it was little less crude than the astrolabe.

Now up to the 16th Century navigators were without the one essential instrument necessary to the accurate determination of longitude. That instrument was an accurate timepiece that could be carried to sea. It is not necessary to have a timepiece in order to learn one's latitude, but longitude is a more difficult problem, and *time* is an element in it. But the watches of the 16th Century were too inaccurate to be of much service, and, as a matter of fact, it was not until 1607 that it was realized that a day is not necessarily made up of twenty-four hours. If one stays in one place it is true that there are twenty-four complete hours from noon to noon, and clocks were designed to register the time *at*



A SEXTANT IN USE

Sextants are used to measure the elevation of celestial bodies—the sun, moon, or stars—in working problems in latitude and longitude.



A SHIP'S LOG

The mechanism at the top is fastened on the ship's rail, and a line with the rotator shown below at its end is allowed to trail in the water astern. The passage of the rotator through the water causes it to turn, the line is twisted, and the log is made to register the miles travelled.

one place. But suppose, as the sun rises to-morrow morning, you board a very fast airplane and fly it at its fastest speed toward the west. Suppose this airplane flies at the rate of 1,000 miles an hour. In twenty-four hours you have flown around the world, and wherever you have been during that time the sun has been just rising behind you. It has been early morning for *you* all the time. Suppose, on the other hand, you had flown east at the same rate of speed. If you started at six o'clock in the morning, in three hours the sun would be overhead—that is, it would be noon for *you*. In three more it would be evening. In six more it would be morning again, for you would be halfway around the world. Six hours later evening would come to *you*, and in another six hours you would be at your starting point and it would be

morning once more—the *second* morning you had seen after you started, but only the *first* morning after for the people you had parted from twenty-four hours before.

Ships, of course, do not travel at 1,000 miles an hour. But they do travel many miles, perhaps several hundred, in twenty-four hours. Therefore, if you start at Guayaquil, Ecuador (I use that, for it is very nearly on the equator), and sail west for twenty-four hours, making 240 miles, your watch will tell you that it is exactly the same time of day that it was when you left Guayaquil. But that is not true. It *is* the same time of day *at Guayaquil*, but you are four degrees west of Guayaquil, and the sun must still travel past four degrees of longitude before the time at the spot you have reached will be what your watch suggests. It will take the sun sixteen minutes to cover that distance, and therefore your watch is sixteen minutes fast.

Great strides were made during the 16th and 17th centuries and many books were published. Probably the first book entirely about navigation ever published was one entitled “*Arte de navegar*,” by Pedro de Medina. This appeared in Spain in 1545. The fact, however, that the subject was not really understood is proved by the acceptance at an even later date of the theory that the earth did not move and that the sun revolved about it.

Charts became greatly improved during the latter part of the 16th Century, owing to the studies of Mercator, after whom the “Mercator projection” is named. The Mercator projection is used in the type of map that shows the entire surface of the earth as if it were the unrolled surface of a cylinder, and is the type which is, perhaps, despite its errors, in commonest use to-day.

But despite many improvements it was not until the 18th Century that modern navigation really began. Then, suddenly, both the sextant and the chronometer were in-

vented in rapid succession—the one in 1731 and the other in 1735. The sextant is the instrument (now greatly perfected) that is used to measure accurately the angles between the horizon and the celestial bodies being observed, and the chronometer is the accurate timepiece (now also greatly perfected) used on practically all sea-going ships to keep a record of the time of the prime meridian of longitude—that is, the meridian numbered zero. Usually, nowadays, that meridian, as I have said, is the meridian of Greenwich, England, for it is at Greenwich that a British observatory is located, and at this observatory the vital data for seamen are compiled.

With the introduction of the sextant and the chronometer the determination of longitude became simple. And latitude, too, because of the sextant, could more accurately be determined.

It is not my purpose to go into detail in explaining the finding of one's longitude, but I shall attempt to explain, simply, the theory.

The sun, during a day of twenty-four hours, covers the 360 degrees of the circumference of the earth. That is, during every hour it passes 15 degrees. If you have a clock that tells you that it is 9 o'clock in the morning at Greenwich and you know that, according to the sun, it is 8 o'clock in the morning where you are, you know that because of that difference of one hour there is a difference of 15 degrees of longitude, and that you are 15 degrees west of the meridian of Greenwich. If you were 15 degrees east, your time would be 10 o'clock.

Now if you have some accurate way of telling what time it is by the sun where you are, and you have a chronometer telling you the time at Greenwich, all you have to do is to subtract the earlier time from the later and work out how many degrees, minutes, and seconds of longitude are rep-

resented by the hours, minutes, and seconds of the difference. If it is later at Greenwich than where you are, you are west of Greenwich; if earlier, you are east.

On the morning of March 7, 1916, I took a sight of the sun when the chronometer showed it was 39 minutes and 1 second past 1. My sextant showed me, after I had made some corrections which I shall not attempt to explain, that the altitude of the sun was $24^{\circ} 58'$. From this, and other data that it is necessary to have, I worked out our time *when I took the sight*. The answer to my problem showed me that the time was 13 minutes and 4 seconds past 8 o'clock. Subtracting this time from the time shown by the chronometer I got 5 hours, 25 minutes, and 57 seconds. Because a difference of one hour of time represents a difference of 15 degrees of longitude, a difference of 5 hours, 25 minutes, and 57 seconds in time represents a difference of $81^{\circ} 29' 15''$ west of Greenwich.

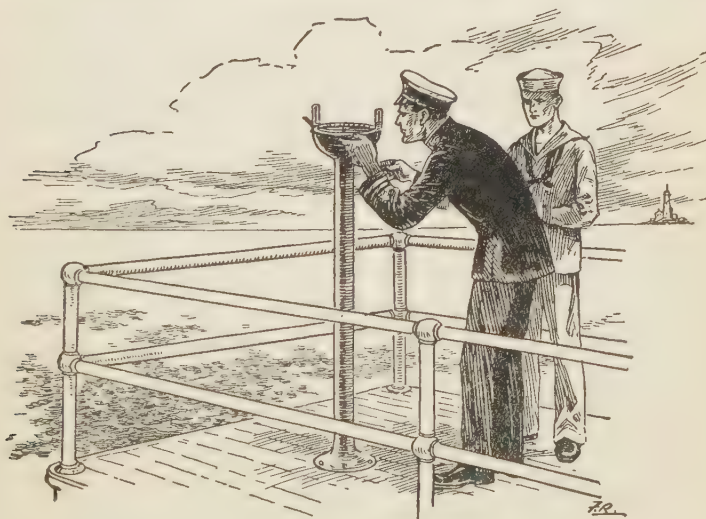
I have purposely refrained from explaining the working of the problem, for that can only be done with such a reference book as Bowditch at hand, in order that the compiled logarithms may be looked up. Furthermore, the explanation is long, technical, and, to the beginner, tedious, and is beside the purpose of this book. I have given the incomplete explanation only to show that to find longitude one must find one's "local mean time," and must have a timepiece showing the "mean time" at Greenwich.

In the foregoing explanation I have left out of consideration several factors vital to accuracy in navigation. For instance, I have not mentioned the fact that the sun is not so accurate in its movements as an accurate chronometer. Sometimes it is a few minutes ahead and sometimes it is a little behind time. From this, two expressions for time have

come into use: "apparent time" and "mean time." "Apparent time" is the time that is shown by the sun; "mean time" is the time shown by the clock. Because there is this difference there must be a correction made for it, and this correction is to be found in the Nautical Almanac, which is a valuable part of the navigator's equipment.

Again, the navigator takes the angle of the sun from the bridge or some other elevated part of his ship. The angle he gets from such a height is slightly different from the one he would get if he were at the water level. Therefore he must make a correction for the difference. This he finds by knowing his elevation above the water and looking up the correction.

There are other corrections still, applying to the sextant angle, to the sun itself, and to time. All of these are neces-



USING A PELORUS

This apparatus consists of a movable plate marked with compass bearings, set in a stand. The observer sets the plate to correspond to the standard compass, and then sights across it in determining the compass bearings of points ashore from which he wishes to learn his exact position.

sary if one wishes to be accurate, and a navigator should always be as accurate as his science permits.

But often it is impossible to learn the angle between the horizon and any of the celestial bodies, for clouds and fog sometimes shut off the sky and the horizon. Sometimes one is clear while the other is obscured; sometimes both are hidden. But still it is necessary to know the position of the ship. As a matter of fact, the heavier the clouds or the thicker the fog the more desirable it is to know one's position accurately. Until recently, however, seamen have had to depend only upon dead reckoning which often is anything but accurate. But now the radio direction finder and the method of learning one's position by asking radio stations ashore to supply it by plotting the directions from which one's radio message reaches two or more of them are coming into more and more common use.

Dead reckoning however, is still highly important, and is used by every careful navigator. It requires considerable experience for a navigator accurately to place his ship by dead reckoning alone. As a matter of fact, if the voyage is long and the sky has been obscured, the navigator expects to find himself somewhat wrong in his estimation of his position and is correspondingly careful. He has had to depend upon his log, which, as I explained in the last chapter, is a kind of nautical speedometer. As a check against this he often keeps a record of the revolutions of his propeller, for he knows, from experience, how far he will sail in an hour with his propeller running at any given speed. This is advisable because seaweed may foul the rotator of his log, or driftwood tear it away or bend it.

In addition to the distance he has sailed he must know accurately the direction he has sailed, and if he has changed his direction he must know when and how much. Furthermore, he must study his charts carefully in order to learn

whether or not he is sailing in a part of the ocean in which there are currents, and if so he must figure out very carefully what effect the current has on his ship.

Suppose a ship was sailing by dead reckoning across the Gulf Stream directly east of Cape Hatteras. The Stream, let us say, is 100 miles wide, and he is ten hours in crossing it. The current flows at the rate of three miles an hour. Therefore, if he has headed straight across, the current has carried him thirty miles to the northeast, and unless he knows how wide the stream is, which direction and how fast it flows, and how long he has been in it, he cannot possibly know just where he is. It is as if you tried to cross a river in a rowboat and pointed its bow at right angles to the shore all the way. The current would certainly carry you downstream, so that you would not land on the opposite side directly across from where you started.

When it is necessary, then, for seamen to sail their ships entirely by "dead reckoning" they are always anxious to check up their positions by any outside aids that are available. It was for this reason that our captain, on the imaginary voyage we took from Philadelphia to Havana in the last chapter, sailed so close to Diamond Shoal Lightship instead of crossing the Gulf Stream and heading out to sea.

I shall add but one more thing before I end this brief and incomplete explanation of navigation and its related subjects. Navigation and dead reckoning we have touched upon. Piloting still remains untouched.

This branch of navigation, if branch it really is, shows the navigator the position of his ship by reference to objects ashore. Let us suppose that a ship has crossed the ocean and is approaching a harbour entrance. While at sea an error of half a mile or so meant little, but as he approaches shore he wants to know *exactly* where he is.

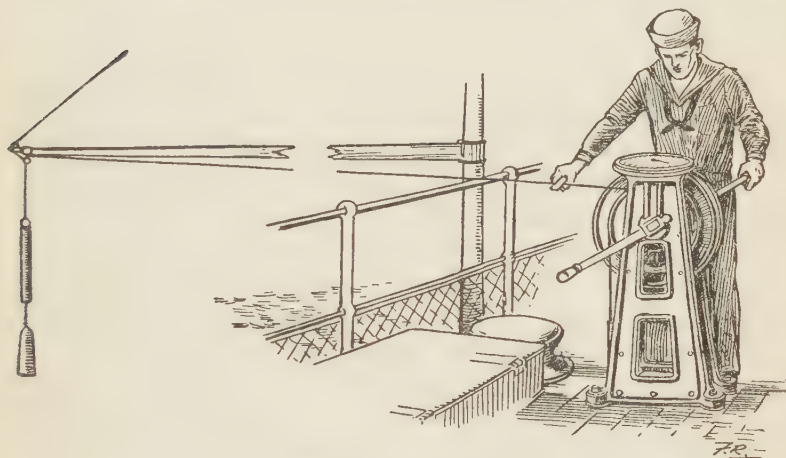
On each side of the harbour entrance let us suppose that

there is a lighthouse. The navigator gets out his large-scale chart of the vicinity and lays it on his chart table. This chart shows the harbour entrance and shows the positions of the lighthouses. Then he determines the direction of these two lighthouses according to his compass. Let us suppose one lies exactly northwest and the other exactly southwest. On the chart, then, he draws two lines, one through the point marking each of the lighthouses. From the lighthouse to the northwest he draws a line extending southeast (the opposite direction) out to sea. From the lighthouse to the southwest he draws a line to the northeast. These two lines cross, and he knows that his ship was exactly at the intersection when he took his bearings. As this can be done in a minute or two the position is very accurate, unless his ship is sailing very rapidly, which it probably would not be. This is known as the "cross bearing" method of learning one's position, and is one of the simplest problems in piloting.

Suppose, however, that a ship is sailing along the shore, and but one prominent object can be seen on the land. The navigator watches until the object (a lighthouse, perhaps) is "four points off his bow"—that is, until the angle between his course and the direction of the object is 45 degrees. From that moment the log is watched carefully, until the object is directly at right angles to the ship's course. The distance sailed during that time is the same as the distance from the ship to the object ashore at the time the second bearing is secured, and if a compass bearing is taken when the ninety-degree bearing has been taken, a line drawn on the chart from the position of the object ashore can be marked with the distance in miles, and the navigator will know exactly the position of his ship at that moment. This is known as "bow and beam bearings." There are other similar methods of obtaining the desired result.

In foggy weather when ships are “on soundings”—that is, where the water is shallow enough to permit of the easy use of a line with a weight attached for measuring its depth—careful navigators invariably use the “lead line” constantly.

This tells them not only how deep the water is, but by



SOUNDING BY MACHINE

A glass tube with the upper end closed and the lower end open is lowered in a special case to the sea bottom, and then brought to the surface. As the tube descends, the water compresses the air in the tube, and gradually creeps up inside. The inside of the tube being of ground glass the water leaves a mark showing how far it has entered the tube. By laying the tube on a special scale the depth to which the glass was carried can be gauged. There are other methods not greatly dissimilar from this.

putting tallow or soap on the bottom of the lead weight they bring up sand or mud or shells from the bottom. With this and the depth, a line is drawn on tracing paper on the same scale as the chart. Along this line these soundings and the kind of mud or sand the lead brings up are marked, at intervals corresponding to the distance the ship has sailed between soundings. The chart is printed with the depth of the water in fathoms and with the kind of bottom that will be found. After the navigator has compiled his data for a

few miles the tracing paper with the line on it can be moved about over the chart, and if care has been taken in sounding and watching the speed and direction of the ship, the navigator will find the place on the chart where his series of soundings will match the printed soundings. Then he will know very accurately where he is, even if it be a fog-enshrouded night.

Many, many important aspects of these three vital subjects have been completely passed over in this short chapter. If, however, I have been able to explain a little of the subjects, and if, particularly, I have quickened the interest of any of my readers in them, my purpose has been served. Going to sea is not so difficult as many people ashore are prone to think. But becoming a thorough seaman and a thorough navigator is not so simple, perhaps, as to become adept at much of the work that occupies men ashore.

CHAPTER XI

LIGHTHOUSES, LIGHTSHIPS, AND BUOYS

JUST as the origin of ships is lost in the darkness of shrouded time, so is the origin of lighthouses lost. Perhaps to guide returning fishermen who all day and into the night had spread their nets or cast their spears for food, the women of some savage tribe of long ago built bonfires on the beach. Still that is a custom among simple folk who live hard by the sea and secure their livelihood from it.

From this the Egyptians of early times probably adopted their idea of lights, that were burned every night at given spots near the shore, in order that ships might find their way by them. Such fires were tended in those early days by priests, and a priestly duty it was—and still remains, although simple, quiet people now tend the lights and consider it only a work to be done—but it is a work of infinite value to the world of ships in which most of the reward lies in the knowledge of a task well done.

A Greek poet, writing about 660 B. C., mentions a lighthouse at Sigeum, a town near the site of ancient Troy, and this was one of the very earliest lighthouses regularly maintained. But in the years that followed this they probably became more and more numerous, and as their importance was recognized they became more and more similar in external appearance to those we know to-day. That this is probably true seems to be borne out by the erection at Alexandria, Egypt, about 275 B. C., of the famous Pharos, which, we are told, was 600 feet high and similar in shape to the minarets so common in Mohammedan lands to-day.

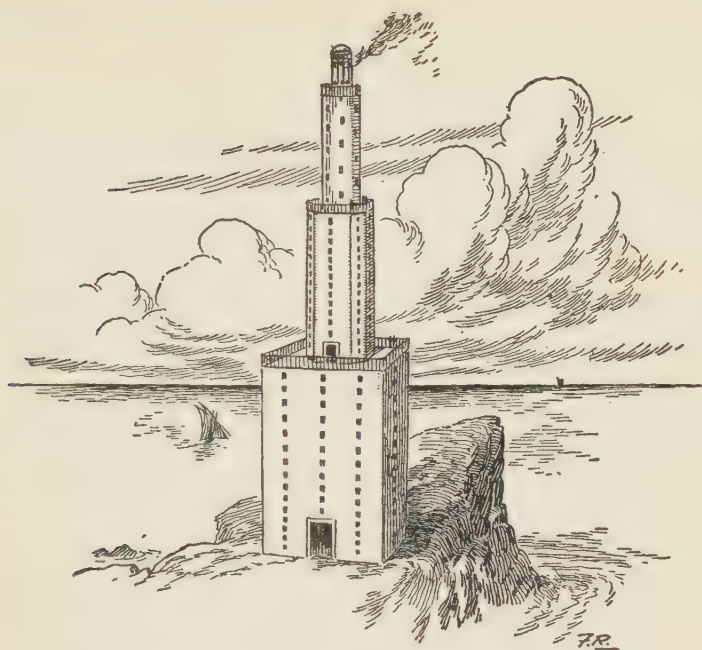
That the structure was as high as it is said to have been seems doubtful, but that it was of extraordinary height is proved by its inclusion among the seven wonders of the ancient world. So impressive a lighthouse could hardly have been the first of its kind, although, no doubt, it far surpassed all others.

At the top of this great tower a fire was kept burning, and for nearly sixteen centuries its great shaft stood the test of time, before it collapsed in an earthquake. Centuries before its end, however, the Mohammedan conquerors had come to be the rulers of Egypt, and near the top of this great tower a small praying chamber was placed. Perhaps from its great height the muezzin called the faithful to their prayers, and certainly its graceful lines left a deep impression on the Mohammedans, for from it came the idea that resulted in the erection of the numerous minarets that mark almost every Mohammedan city of the earth.

And ere the convulsion of Nature toppled this striking edifice to the earth the idea of lighthouses had greatly widened, and widely separated lands had built lighthouses of their own to guide the sailor as he sailed the sea.

Rome built many along the coasts her ships were forced to visit, one at Dover and one at Boulogne being, probably, the earliest on the shores of England and of France. Both of these are gone, leaving only traces of their existence, but the ruins of the ancient tower at Ostia, at the mouth of the Tiber, still remain to remind us of great galleys that were guided by its fire in the nights of the first century after Christ. At Corunna, Spain, there still stands an ancient Phœnician or Roman tower, known as the Pillar of Hércules, and from its top, in ages now long dead, a flaring beacon marked the spot for sailors far at sea.

But all of these earlier lighthouses were built on dry land, sheltered by the shore from the crash of waves. It was the



THE PHAROS AT ALEXANDRIA

One of the seven wonders of the ancient world, and one of the first great lighthouses.

city of Bordeaux, on the Gironde River in France, that first built a lighthouse on a wave-swept rock to warn ships from its treacheries.

The Gironde River flows into the stormy Bay of Biscay, its wide mouth often filled with foaming waves driving in from sea, which crash upon a rocky reef that lies in the very centre of the estuary. So great a toll of passing ships was taken by these rocks that the thriving city of Bordeaux was like to lose its water-borne commerce, and to keep the trade that meant so much to the city the citizens agreed to mark the spot with a light. A simple tower was erected on this spot about the year 805. For years it served, until Edward

the Black Prince, temporarily in control of the vicinity, erected a slightly greater tower. For a time this, too, was kept, but finally, an aged keeper having died, the fire was no longer lit. For many years the rocks remained unlighted, and then, in 1584, during the reign of Henry II of France, a new lighthouse was begun. For twenty-five years the work of construction was under way, and when it was completed it was the most magnificent lighthouse of all time. Nor has another been built since to equal it in magnificence. About its base a great stone breakwater was built, surmounted by a balustrade. The lowest floor of the structure contains a beautiful hall and an apartment originally intended for the king. Above is a chapel, beautifully designed and decorated, and above this stands the tower which contains the light. This, originally, placed the light about one hundred feet above the rocks. Later the tower was increased in height to 207 feet and now it is equipped with the most modern apparatus, visible in clear weather for twenty-seven miles, to take the place of the blazing log fire that for so long did its best to guide the mariners in from sea.

Until the 18th Century the fires of these beacons burned wood, and then coal came gradually into use. The objections to such fires are obvious. They had no definite range, for fires died down or burnt furiously, and when a strong wind drove in from sea the fire was often all but hidden from sight of ships as it curled around in the lee of the tower.

But America had been settled and had such lighthouses on its own coast ere other methods superseded this.

The first lighthouse in the United States was the one on Little Brewster Island on the south of the main entrance to Boston Harbour. It was built in 1716, although the lighthouse now occupying that site was erected in 1859. During the Revolutionary War the structure was destroyed and

rebuilt three times. The third structure was a stone tower sixty-eight feet high, and four oil lamps were used to illuminate it.

Wood and coal fires continued to be used, here and there, until the 19th Century was well begun. The last one of these in England to give way to more improved methods was the Flat Holme Light, in the Bristol Channel, where coal was burned until 1822.

During the 19th Century, however, great improvements were made in lights, and equal improvements were made in the design and construction of lighthouses. The story of the development of lighthouses is one of dramatic intensity, filled with accounts of heroism, of ingenuity and perseverance. And not only in the building of lighthouses has heroism been



THE TILLAMOOK ROCK LIGHT STATION

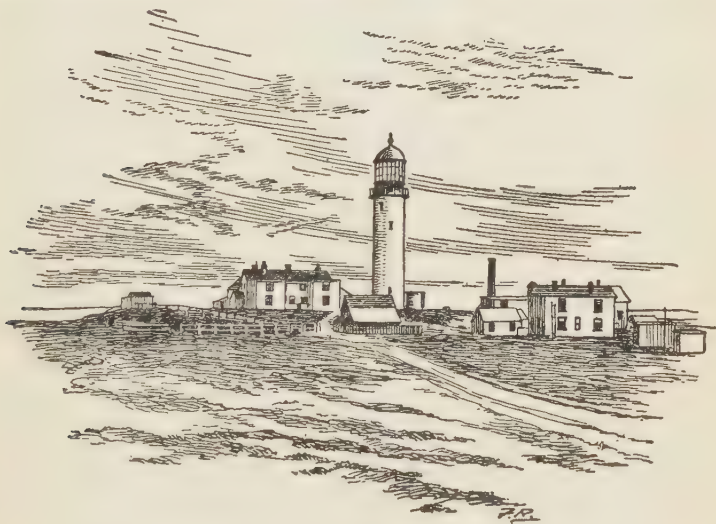
This great rock, which lies about a mile off the coast of Oregon, was formerly a spot of terrible danger to ships. Great difficulties had to be overcome in order to erect this lighthouse, but now its 160,000-candle-power light is visible, in clear weather, for eighteen miles.

shown. The courage of the quiet men who man them—and women, too, for there are many to whom lighthouses are entrusted—in itself is the subject for a book. Courage and unselfish devotion to duty are the fundamentals upon which keepers of lights base their helpful lives. Regardless of comfort, regardless of danger, regardless of life itself, *the light must burn*. No other duty or desire compares with that determination. And so in calm or gale, in summer fog or storm-torn winter night, the men who sail the sea have come to depend with simple and abiding faith upon the lights, the foghorns, and the courage of the lighthousemen. Whether the Atlantic pounds with mountainous seas the slender shaft on Bishop's Rock, or the Pacific piles its crashing surges high at Tillamook; whether the hot winds of Arabia blister the paint on the web of steel that holds the Red Sea light of Sanganeb Reef, or ice encrusts the giant light that guards Cape Race, the light must burn, and sailors out at sea sail past almost as confident of these lights as of the stars.

To one who has not seen the vast strength of the angry sea my words will mean but little, but any one who has seen needs no description and will not forget. Imagine a slender tower, built amid the smother of foam on a wave-swept rock. Imagine the supreme impudence of man who boldly sets himself the task of building there a cylinder of stone surmounted by a cage of glass. Nor does his impudence end there. Although it may be that for weeks at a time no boat may come near the spume and flying spray about the rocks above which stands the tower, yet in the tower are men. They calmly go about the tasks assigned to them. They polish the powerful lenses about the light. Each night they light the lamp. When fog obscures the spot they set their foghorn going. These are their duties.

And when storm threatens, do they leave? Not so, for then above all times is their duty clear.

Overhead fly the scurrying clouds before the storm. Below, the sea turns gray. A whitecap dots the surface of the water, and a sudden puff of wind leaves a ruffle of little waves as it passes. The clouds grow darker and the lightning flashes. The thunder snaps and roars and then comes the wind. Its voice is low at first as it whisks away the wave crests and



CAPE RACE LIGHTHOUSE

A 1,100,000-candle-power light now marks the great Newfoundland headland of Cape Race. Near this cape lies the shortest sea route from the English Channel to Boston and New York, and ships entering the St. Lawrence River also must pass near it.

tears them into spray. The tattered water slaps against the brown rock of the tower. The wind increases, blowing up the waves. They pound with growing strength against the foaming reef, and leap up higher toward the glass cage that marks the tall tower's crest.

The lightning flashes more, the thunder roars again. The wind goes wild and shrieks like mad, tearing water from the sea and throwing it high over the summit of the tower.

The great waves boom as they pile up on the rocks. They crash against the tower which shudders with the blows. Surge after surge pounds savagely on the great rocks of the reef, and finally a mighty wave that seems to be a giant effort of the madly tortured sea lifts a raging crest high up, and drops it in the roaring surf. A great rock splits beneath the blow, the wave runs up the tall thin shaft and dashes high above its top, and then drops swiftly down, while there, unharmed amid the vastness and the terror of the storm still stands the tower that puny man has built to warn ships from the dangers that surround it.

The story of lighthouses is one to hold the interest of any one, and many books have been written telling it. "Lighthouses and Lightships," by F. A. Talbot, is one of these, and from its pages one may take a new impression of the men who spend their lives in making the sea less dangerous for those who travel on it.

My task is different. I have space only to devote to why lighthouses exist and how they help sailors. And with lighthouses I shall include lightships—which, of course, are merely lighthouses that float—and buoys, which are used for many things.

Originally it is likely that lights were built ashore in order that sailors overtaken by night while on the sea could be directed to a landing place. Compasses, of course, were unknown, and while it is possible to sail a course by the stars, it is quite another matter to find a landing place by such means. Consequently, lights were built to mark shelving beaches or the entrances to harbours where ships could be landed.

But the light erected in 805 by Bordeaux was for the opposite purpose. It marked a place to keep well clear of, and lighthouses do that to-day almost exclusively.

If a reef lies near a course followed by ships a light must



MINOT'S LEDGE LIGHT

Which marks, near the entrance to Boston Harbour, a rocky reef seldom seen above the surface of the water. From this spot, the famous old skeleton iron lighthouse that formerly marked the reef was swept by a gale in 1851.

guard it. If a sand bank is hidden from the sight of ships that might ground on it a light must be there as a warning. If an island constitutes a menace because swift currents flow past its shores a light must tell the sailor where the danger lies. Nor are lighthouses useful only at night. In daylight they form conspicuous marks from which the navigator may learn his exact position. In fog their huge foghorns wail like lost souls, sending warnings far into the engulfing mist in order that sailors may hear and know that land is near.

Then, too, each light is individual. One flashes regularly, one irregularly, one red and white, one red alone. Other lights are steady beams, but each can be recognized, and so they are like friendly faces, recognizable, every one.

Perhaps the coast of France is the best lighted in the world. Certainly it would be difficult to imagine one with a more perfect system. I have sailed the coast of Brittany at night, fearful of the currents and the storms that often blow on the stormy Bay of Biscay. But always, to minimize the dangers of the rocky coast and hidden reefs, the light-houses blinked, and the task is simple to determine one's position any time, except in fogs. For the French have placed their lighthouses so that as a ship sails along the coast there are always at least two lights in sight at once. From these, cross bearings can be taken at almost any moment, and the careful navigator, in clear weather, need never feel uneasy as to his position. Ushant Island, that rocky islet just off the coast of Finisterre, was long a graveyard of ships—and still, from time to time, some ship is caught on its rocks—but now bold lights stand high above the smother of foam and the roar of breakers, marking the spot in order that ships may carefully give it a wide berth.

Formerly every lighthouse had to have attendants, as the most important still have, but modern improvements are making unattended lights more and more common. One finds them everywhere. The rocky coast of Sweden, the firths of Scotland, the mountains of the Strait of Magellan, the gorgeous coast of Indo-China all have many of these new beacons.

They flash accurately at regular intervals. They light their lights at dusk and turn them out at dawn. Some roar through the fog with their great warning voices, and all of this is automatic or semi-automatic. So far as the lights themselves are concerned they require no attention for

months at a time. The sun turns them off as it rises in the morning, and as it sets, the delicate apparatus that its light expands contracts once more and the light is turned on. From time to time a tender visits each of these. The apparatus is overhauled, the supply of fuel renewed, and again for months the light performs its task.

Nor are all lights placed in lighthouses. Many spots require other means, and lightships have been designed and built to perform the duties of lighthouses where lighthouses cannot be built.

To transatlantic travellers perhaps the most familiar of these is the Ambrose Channel Lightship, that rolls and pitches at its anchor outside the entrance to New York



BISHOP ROCK LIGHTHOUSE

On a cluster of rocks off the Scilly Islands near the entrance to the English Channel where converge the most important of all the world's shipping lanes.

Harbour. But the most famous lightship on the American coast is the one that marks Diamond Shoal, that infamous spot just off Cape Hatteras. Several times the Government has attempted to build a lighthouse on this shoal, but the attempts have invariably been frustrated by the sea. A lighthouse does mark the Cape, but Diamond Shoal runs out beneath the stormy water for about nine miles from the Cape, and it is this dangerous sand bank that the lightship guards. Four and a half miles out from the bank the lightship is anchored in a stretch of water that has hardly a peer on earth for the frequency and suddenness of storms. Here this little ship jerks at her anchor, pounded by great seas, tugged at by swift currents, swept by fierce winds. She rolls and pitches, shipping seas over this side and then that, and jerking—always jerking at her cable. There is no easy smoothness to her roll as there is with a free ship at sea. There is no exhilaration to her pitch as she rises over the seas and plunges to the troughs, for always the jerk of the cable interferes, and from one month's end to the next the little crew endures the discomfort and the hard work, in order that ships may be warned away from the treacherous sand of Diamond Shoal.

These sturdy little ships do mark other things than dangers. In many cases they are the modern counterparts of the beach fires of those early peoples which lighted belated boats in to shore. To-day, however, those lightships which perform this task swing at their anchors outside the entrances to harbours, marking the channel through which the ships must pass on their way in from sea.

In this duty they are similar to the lighted buoys which, in recent years, have been put to so many uses, the lightships being, however, greatly more conspicuous and generally marking a spot well outside the entrance to the channel.

Buoys are of many uses and of many shapes and sizes,

marking danger spots, submarine cables, sunken wrecks, channels, as well as temporary obstructions. Some are used for mooring ships in harbours, some carry bells or whistles for sounding warnings, some carry lights. Attempts have been made to standardize the shapes and markings of buoys in all countries, but many lands still maintain



FIRE ISLAND LIGHTSHIP

This lightship is anchored off Fire Island, near the southern coast of Long Island, U. S. A. Lightships sometimes mark shoals, and sometimes mark the entrances to harbours. They are always kept anchored in given spots and are merely floating lighthouses, although, of course, they are sometimes relieved by other lightships so that they may undergo repairs.

their own designs, and the officers of a ship visiting strange waters must acquaint themselves with the particular designs there in use.

Buoys are of scores of different sizes and designs. They may be nothing more than tall painted poles of wood anchored to the bottom in shallow water and standing more or less vertically. These are called "spar" buoys, and are useful if ice is floating in the waters that they mark, for as

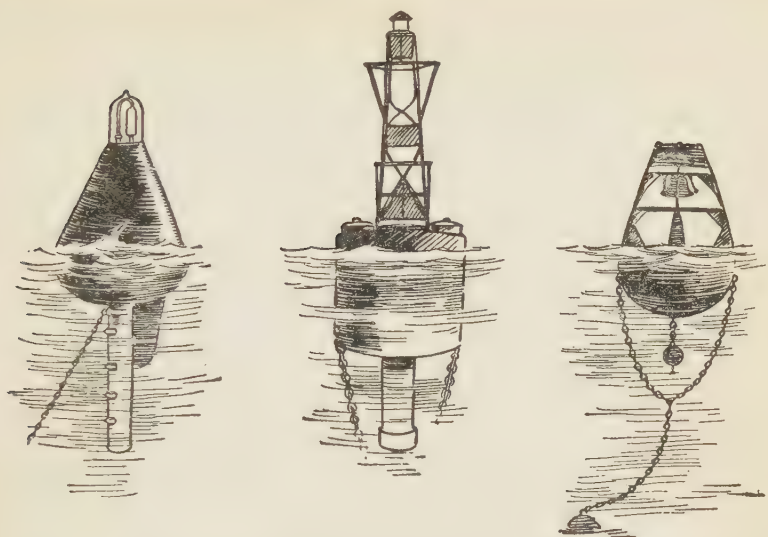
the ice floats against them they give way, the ice passes over them and they serenely reappear, none the worse.

On the other hand buoys may be huge structures of steel many tons in weight, forty feet from top to bottom, ten feet in diameter, and complex in their equipment of lights or whistles or bells. Or they may be great barrel-like steel floats, or conical ones, or great turnip-shaped floats. Some are spherical, some are of stranger shapes. They may be red or black or green. Some are striped, with weird decorations gracing their tops. Some support small triangles or spheres, some crosses, some paint-brush-like affairs. But each one has its particular uses, and one should hesitate to pass a buoy unless the thing it stands for is understood.

In United States waters, for instance, one needs to know that in coming in from sea a ship should pass with the red buoys, which are conical in shape and are called "nun" buoys, on the starboard, or right side. These buoys are further distinguished by being numbered with even numbers. At the same time all "can" buoys, which are black and cylindrical, with odd numbers painted on them, should be kept to the port or left side. Sometimes "spar" buoys replace these, but the buoys to starboard will always be red, the buoys to port black, as the ship comes in from sea.

Buoys painted with red and black horizontal lines mark obstructions with channels on both sides. Buoys with white and black perpendicular stripes sometimes mark the middle of a channel and a ship should pass close to them. Buoys marking quarantine are yellow, while buoys marking the limits of anchorages are usually white.

The whistling buoys and lighted buoys are, perhaps, the most interesting of the lot. Imagine a huge steel top, with a whistle placed at its point, and a large steel tube running through it from top to bottom, extending more than the height of the top above it. Imagine this top ten or twelve



AUTOMATIC BUOYS

The whistle buoy at the left utilizes the motion of the waves to blow a whistle. The light buoy in the centre has an automatic light that burns gas stored in the body of the buoy. The bell buoy at the right carries a bell, against which four clappers are pounded by the action of the waves.

feet in diameter, and, with the tube, forty feet in height. Imagine this, then, floating in the water, point up, and with the tube below the surface. The end of the tube below the water is open. The end on which the whistle is mounted contains two openings. In one of these the whistle is placed. The other opening is closed by a valve which permits air to enter, but closes when the air tries to escape. This buoy is anchored in the water, and as the waves toss it up and down they rise and fall in the lower part of the tube. As they rise the air inside is compressed and is blown through the whistle causing it to sound. As the water in the tube falls, air is drawn through the valve, and again the waves force it through the whistle. This ponderous but simple "whistling" buoy requires no supplies and almost no attention. Peri-

odically it is visited by a tender and is temporarily relieved of work while it is taken to the repair shop to be examined, repaired, and painted. Aside from that it needs no attention, yet constantly it moans as the waves sweep under it, and the greater the waves the greater is the volume of its sound.

Bell buoys are equally simple and effective. These buoys are surmounted by a framework of steel from which a large bell is rigidly suspended. Several "clappers" are hinged about it so that, no matter how a wave may move the buoy, a clapper strikes the bell.

The light buoys are more complicated and more diverse. There are more than a dozen different sizes and shapes, and the fuel is usually compressed oil gas or compressed acetylene gas. The buoys themselves—that is, the floats—may be of almost any shape. Some are spherical, some cylindrical. Some are long and thin, and others short and fat, but each one has a framework or a shaft of steel extending from ten to twenty feet above it. At the top of this the light is fixed, while the body of the buoy holds the gas. These lights flash intermittently, the gas, which is under pressure, operating a valve while a tiny "pilot light" in the burner remains always burning in order to ignite the gas when it is turned on to cause each flash. Some of these buoys carry a supply of fuel great enough to last for three months, and during that time they flash their lights every few seconds without fail, marking a danger or a channel, and are visible, sometimes, from distances of several miles.

Thus the dangers of the sea are marked by lighthouses, lightships, and buoys, while harbour entrances and channels are marked as well. This has been done in order to save life and property and in order to expedite the passages of ships. No more do captains have to depend on guess and luck. Their accurate sextants and chronometers tell them where

they are on the trackless sea. Their barometers tell them of approaching storms. Their compasses tell them their directions.

And men ashore have built great lights on wave-washed rocks and surf-pounded beaches, on mighty headlands and shoals of sand. Lightships mark the treacherous spots where lighthouses cannot be erected, and mark, as well, the entrances to many harbours around the world. And once past these the mariner is led into the shelter of the harbour between long lines of buoys, each telling him its message, each aiding him on his way. He rounds a rock in mid-channel unscathed, because a buoy anchored there tells him how to turn. He finds his anchorage because of other buoys, and perhaps he makes his ship fast to still another, and knows that once more the ocean has been crossed in safety and his voyage is ended.

Almost the whole of the surfaces of all the lands of earth bear the marks of man. Most people live their lives ashore amid nature that has been radically changed by man. Cities have been built, railroads flung across the land. Farms flourish and ploughs have turned up every inch of all their acres. A hundred years ago America was wild from the Alleghanies to the Pacific. Now one cannot cross it and be for more than a few minutes out of sight of signs of men.

But the ocean rolls ever on just as it rolled in prehistoric times. No mark that man has made has changed the sea. Yet, while man is unable to change one single thing about its solitary waste, he has marked its greater perils and has conquered it. The perils of the sea are growing ever less, and ships owe much of this to the lights that mark its danger spots.

CHAPTER XII

SHIP DESIGN, CONSTRUCTION, AND REPAIR

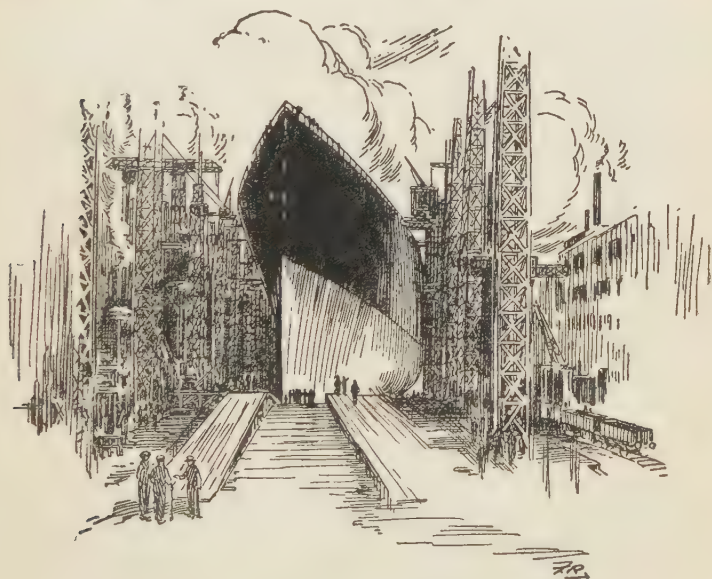
SHIP design, prior to the opening of the 19th Century, was based very largely on rule-of-thumb methods. In ancient times, before Greece became a sea power, this was particularly true. Shipwrights and sailors came to know from experience what qualities were good and what were bad, and after many years at their work were able to construct ships with some understanding of what the ship could be expected to do.

It took only a little while for them to learn that narrow ships were easier to propel than broad ones but that broad ships possessed carrying power superior to that of narrow ones. Thus the merchant ships were "tubby" while warships were narrow. If a ship proved to be unseaworthy in heavy weather shipwrights naturally did not build other ships like her if they were looking particularly for seaworthiness. If a ship was able, it was only natural that her characteristics should be incorporated in other ships. If a ship otherwise satisfactory permitted seas to come aboard over bow or sides or stern, the sailors and shipwrights tried to correct the difficulty without losing her good qualities. Thus from generation to generation ships improved, although the process was slow.

When Greece was at her zenith there seems to have been a more thorough study made of structural design, and many things about ships were more or less standardized. Just how far the Greeks carried their study of ships it is impossible to say, but crude methods gave way to finer ones, and Greece

passed its understanding of ships on to Carthage, and from the Carthaginians it went to Rome. But the Middle Ages lost this information, as it seems to have lost almost everything else, and a new beginning had to be made.

The Norsemen went through a similar development. The seas their ships were called upon to sail were almost always boisterous. The principal use to which their ships were put was war. They had, then, need to be both seaworthy and fast. The early crude attempts of the Norsemen, therefore, grew slowly into those beautiful ships for which they are famous. To-day the seaworthy whaleboat is very similar to the finest examples of the old Norse "serpents." These old ships were long, narrow, pointed at bow



A SHIP ON THE WAYS

While a ship may look large on the water, she looks gigantic when on land. The great hulls and the collection of scaffolds and machinery in a shipyard are always a source of surprise to the visitor who is unfamiliar with the construction of ships.

and stern, and had both ends raised, while amidships they were low. The sheer, that is, the line from the high bow to the low section amidships, and from there up again to the stern, was a beautiful sweeping curve. Such ships readily rode rough seas, while their low "freeboard" amidships permitted the oars to be used to good advantage, and their narrow hulls presented a minimum of resistance to the water. This refinement, however, can hardly be said to have resulted from thought so much as from experience. By that I mean that these ships at the highest stage of their development were not consciously designed, but were outgrowths from experience, and that the shipwrights, only after many generations, had learned that such a design combined the advantages they particularly desired.

It was with the Crusades, as I have said before, that ships began to improve more rapidly. This was due to the broadening spheres of travel of western European sailors. They visited the Mediterranean and Asia Minor, and found in that part of the world ships that were strange to them. But in these strange ships they found characteristics that they deemed desirable, and, combining these desirable points with those of their own ships that were equally desirable, they produced improved types. Thus they profited by the experiences of others who, in their own little spheres of activity, had gradually developed ships that answered, at least to a considerable extent, the requirements of their own localities.

It hardly needs to be pointed out that the British, who sailed the rough waters of the North and Irish seas and the English Channel, developed ships far different from those developed by the peoples of Mediterranean countries, where the distances sailed were shorter and the weather conditions were so radically different.

After the Crusades had introduced the peoples of western

Europe to those of the Mediterranean, trade between the two increased, and, so far as ships were concerned, each learned from the other. Thus it was that by the time Columbus sailed on his famous voyage, the sea-going ships of all the European countries had grown somewhat similar in design and appearance.

A few glimmerings of the complicated subject of naval



A FLOATING DRY DOCK
And a ship undergoing repairs.

architecture became evident in the years that included and followed "the age of discovery," and ships, or at least *some* ships, were "designed" by men who made a study of them. The designs, however, were largely little more than the transfer of rule-of-thumb methods to paper, and a real understanding of the subject was still far distant. Phineas

Pett, during the 17th Century, designed many ships for the British Navy, and from these designs the ponderous ships of later days developed. In France, however, naval architecture seems to have been a better-understood art than in England, for many times British designers improved their ships after studying captured French ships.

The designers in England for many years were guilty of one error in particular which, while later corrected, proved to be the cause of the loss of several of their very greatest ships. This fault was the placing of the lowest tier of gunports so close to the water that when the ships were under a press of sail the ports on one side or the other, and they were not watertight even when closed, were under water. During the reign of Henry VIII, a British ship named the *Marie Rose* heeled over when getting under way, and the ports, which were open and were only sixteen inches above the water when she was on an even keel, permitted the water to enter in such quantities that she sank. Years later Sir Walter Raleigh wrote that this defect was being corrected, yet later still the *Royal George* was lost because of the same fault.

It is interesting to quote a few lines of Raleigh's writings on ship design. Commenting on improvements in lines he said that ships with these improvements "never fall into the sea after the head and shake the whole body, nor sinck a sterne, nor stoope upon a wind." He also suggested that the lowest tier of gunports should not be less than four feet above the water. Furthermore, he objected to the high sterncastles which made the ships of the time both unseaworthy and ridiculous.

Modern scientific naval architecture can properly be said to date from the latter part of the 17th Century, for it was then that the first studies were made of the passage through the water of various shaped hulls. Before this, ships were

built and if they were successful were copied; if unsuccessful they had less influence on later design. Now began a study that has been carried down to to-day, and scientific deductions began to be made, and upon these investigations and the results of them an important part of naval architecture has been founded.

Still, however, this new science was crude. One reason for this was that ships depended upon the wind for power, and it was a slow task to compile comparative data. That this was not impossible, though, is proved by the brilliant American designers of the first half of the 19th Century, who suddenly evolved the clipper ships that so far surpassed all previous sailing ships that comparison became mere contrast.

But it was steam that made it possible for naval architects to develop their profession to so high a point as it has reached. It was during the 19th Century, then, that naval architecture made its greatest progress. Since the 19th Century great improvements have been made, it is true, and many facts have been discovered, and naval architecture still is progressing, but the 19th Century made a profession of it, and the 20th Century is only continuing its development.

The profession of the naval architect is one that is not widely recognized or understood. When Cass Gilbert designs a Woolworth Building we recognize him as a great architect, and realize, to some extent, the great task he has so successfully completed. When the building is built we view it with interest, perhaps with awe, and comment on the brilliance of the architect and the ability of the constructor. And they deserve all the credit they get—and more.

But how often have you ever heard mention made of the architects from whose brains were evolved the *Mauretania* and the *Leviathan*, the *Belgenland* and the *Majestic*? True,

it is commonplace to marvel at their size. But who thinks of the titanic task that faced their designers?

And now imagine a Woolworth Building being built on a sloping runway, and, when completed, slid bodily into the water, across thousands of miles of which mighty engines placed inside could drive her at express-train speed. Imagine such a structure, with all the magnificence of appointments that are to be found in the Woolworth Building, forcing its way through winter storms with waves pounding madly at its sides—waves which, striking the ironbound coasts of Maine or Wales, sometimes tear away tons of the living rock and hurl it about in a smother of foam. And then compare such a structure with the greatest ships of to-day. There are several far longer than the Woolworth Building is tall, but these vast steel hulls do not rest on foundations of steel and concrete—immovable. They float in the water, and may pitch and roll in the giant swells of the deep sea, but still their huge steel frames easily bear the strain, and while a tremor of the earth might dash skyscrapers disastrously about our ears, the almost constant motion of the sea, whether violent or weak, affects them little. For such work as this the architects of ships deserve all praise.

In such huge and complicated structures as ships have grown to be, repairs, naturally, are frequent and vital. The ordinary wear to which the machinery is subjected necessitates constant adjustments and replacements. Improved mechanical apparatus sometimes is installed to take the place of less reliable or less economical apparatus. The action of sea water on the exposed metal and the collection below the water line of barnacles and other marine growths require periodic attention, while paint seems for ever necessary and, at least on warships, wet paint is omnipresent.

Before the introduction of iron and steel, ships were comparatively small, and consequently it was a simpler job to



THE OLYMPIC

A sister ship of the ill-fated Titanic, and operated by the White Star Line.

haul them out of water or ground them at high tide in order that, when the tide had gone out, their underbodies could be examined and repaired. Sometimes, again, tackle made fast to their masts and led to anchors dropped well away from their sides or to points ashore made it possible for ships to be hauled over to one side or the other, bringing a large part of their underbodies above water, where their crews could make the necessary repairs, or scrape off most of the accumulation of marine growth.

Nowadays, however, when the very smallest of our ocean-going steamers is many times the size of Columbus's largest ship, such methods avail little. Sometimes, still, in harbours where there is a large rise and fall of tide the smaller

ships avail themselves of it for minor repairs, but for most modern ships such methods are impossible and dangerous.

Yet even the greatest ships must from time to time be taken out of the water for repairs and for the inspection of the hulls, and for this purpose dry docks, or, as they are sometimes called, graving docks, came to be designed.

Dry docks are long narrow basins, the dimensions of which are slightly larger than the largest ships they can accommodate. Nowadays they are usually built of reinforced concrete, although brick and stone are sometimes used, and formerly timber dry docks were not uncommon in the United States. The entrances to these basins are equipped with hinged gates, or a floating or sliding caisson. Dry docks in the United States ordinarily use the floating caisson. European dry docks commonly use the other two. These seal the mouths of the dry docks, preventing the entrance of water from the outside as powerful engines pump the water from the dock itself.

The sides of dry docks are usually built in steps, so that at the top they are wider than at the bottom. The bottom is very nearly level, but there are careful arrangements made for draining all the water into pits from which it is pumped out.

Extending almost the length of the centre of a modern dry dock is a row of large wooden blocks, called keel blocks. These can be moved and are made fast when they are put in place. Often this row of blocks is paralleled on each side by a row of somewhat similar blocks called bilge blocks which run along tracks laid at right angles to the line of keel blocks. The bilge blocks can be moved individually along these tracks by means of ropes and pulleys. These ropes are extended up the sides of the dock so that, even when the dock is filled with water, each individual bilge block, and

there are scores of them in each row, can be moved back and forth by men beside the dock.

When it is necessary for a ship to be docked her docking plans are given to the man in charge of the dock. He then arranges the keel blocks so that the line along their tops is the same as the line along the keel of the ship. Certain marks are then made at the top of the dock's side walls to show just how far the ship is to be hauled into the dock. When these arrangements are completed the dock is flooded, the gates are opened, or the caisson is floated out and the ship is very carefully and very slowly hauled into the dock. She never goes in under power, for the clearance between her sides and the sides of the dock is often very small, and the greatest of care must be taken to keep her from coming in contact with the masonry.

When she has been hauled up to the point marked on the dock side she is carefully made fast with cables, and the entrance to the dock is closed. The ship must be riding on an even keel, for if she is listing—that is, leaning to one side or the other—she may damage herself when the water is pumped out and she comes to rest on the keel blocks.

As the water level is reduced her keel slowly settles on the keel blocks which support the whole weight of the ship, but in order to prevent the ship from toppling over sideways the bilge blocks are pulled carefully under her. As they are slightly higher than the keel blocks they touch her bottom at some distance from the keel, and as there is a row of them on each side they keep her securely upright. Care must be taken that none of these bilge blocks come in contact with the ship where any of her numerous underwater valves project, for if that happened the valves would be damaged. The docking plan referred to, however, shows where such protuberances are and such accidents need not occur.

In dry docks where bilge blocks are not used, the ship is

supported instead by "shores." A "shore" is a long timber which is placed with one end against the ship and the other against the side of the dock. In order to make them fit snugly great numbers of varying lengths are kept on hand and are chosen so that they come within a few inches of filling the space between the ship's sides and the dock wall. Then large wooden wedges are driven in between the dock wall and the end of each shore. Dozens of these are placed about a ship and serve the same purpose as is served by the bilge blocks.

A ship I was on some years ago was rammed by a coal barge while at anchor in the harbour of Brest, France, and was forced to go into dry dock for repairs. Being familiar with dry-dock procedure only in the United States I was unprepared for what has always since seemed to me to be a thoroughly picturesque method of placing the shores.

Our ship was hauled into the dock, the gates were closed, and the pumps began to lower the water. Finally she settled on to the keel blocks and the shores were floated into place, each end being held from above by a line. As the water sank lower the wedges were inserted between the shores and the dock walls, and a man with a large wooden mallet took his place at each wedge. Then the foreman, standing at the head of the dock began a song which the mallet bearers took up, singing beautifully in unison, their voices booming upward from the dry dock, halfway down the sides of which they stood. And as they sang they kept time with great strokes of their mallets on the wooden wedges, the musical wooden sound ringing in unison with their song as every man drove his crashing blows with every other man.

I stood on the bridge of the ship listening to the lilting song, and the great musical crashes that punctuated it, every man striking at exactly the same instant that every other man struck. Never before or since have I seen a more

practical demonstration of the uses of song or heard so beautiful a song of industry. It was an "Anvil Chorus" with a different setting.

There is another type of dry dock that is widely used and is of great importance where it is too expensive or difficult to build the type to which I have just referred. This other type is the floating dry dock. In principle it is a huge barge, rectangular in shape, and with highly raised and very thick sides and open ends. Its bottom is built up of many compartments and its "reserve buoyancy" must be at least a little greater than the total weight of the largest ship it is designed to accommodate. That is, it must be able to float while carrying a load of 15,000 tons if it is meant to be used by ships up to that displacement.

These floating dry docks need only to be placed in a sheltered spot where the water is deep enough for the dock to be sunk so that the dock floor is a little farther beneath



THE AQUITANIA

A British built ship operated by the Cunard Line.

the surface than is the keel of the ship that is to be docked. When everything is in readiness—that is, when the keel blocks are properly placed and the incoming ship has been otherwise prepared for—water is allowed to enter the inner compartments of the dry dock. Gradually the whole thing sinks until only the two high sides are visible above the water. When it has sunk until there is enough water over the dock floor for the incoming ship to float in, the valves are closed and the ship is hauled in and made fast. Then giant pumps begin to expel the water that has been allowed to enter the compartments. This causes the dry dock to come once more to the surface, and as it rises beneath the ship the keel blocks press up on the ship's keel, shores or bilge blocks are put in place, and when the ponderous float regains the surface there is the ship, high and dry, where men can scrape and paint and repair her or accomplish the other tasks assigned to them.

It is interesting to watch the labours of a crew of workmen in a dry dock. If a ship looks large in the water, it looks startlingly gigantic in a dry dock, especially if one walks down to the dock floor and views the high bow or the overhanging stern from the level of the keel. Propellers from a distance look small, but with half-a-dozen men realigning their blades or working about them, they look huge indeed.

A hundred men may be swinging on scaffolds which are hung over the ship's side by lines from the deck, and they remind one who is watching from a distance of flies or ants on a wall. A regiment of workmen may disappear beneath the huge bulge of the ship's underbody in order to scrape or paint or repair. Fathoms of cable may follow an anchor from the hawse pipes to the dock floor as the "ground tackle"—that is, the anchors and cables—is cleaned, painted, and examined. Propellers or sections of propeller shafts may be swung over the yawning dock and lowered into it by great

cranes, to take the places of others lost or damaged. Sections of the ship bent or cut by collision may be replaced to the raucous tune of nerve-shattering riveting hammers. Rivets loosened by the "working" of the plates or by galvanic action may be renewed. Plates damaged by any of a hundred causes may be replaced, and great piles of barnacles



THE PARIS

A French merchant ship, operated by the French Line.

scraped from the steel skin of a ship that has been overlong between dockings may accumulate on the dock floor. Sea valves are reground, the rudder is examined, propeller-shaft supports are looked over, and, when the work on the ship's great underbody is completed, the workmen take their tools and depart, great valves are opened in the dry dock walls, the water enters, and once more the great ship floats. The dock gate or the caisson is removed, and carefully the mon-

ster of the sea is backed from her gigantic hospital, fit, so far as her underwater parts are concerned, for another round of duty at sea.

But dry docks are not necessary for all the repairs a ship might need to undergo. To replace or repair engines she may go alongside a quay or a pier, and for any of a thousand jobs she need never stop her regular voyages. But repairs or changes are always under way. To the voyager on a handsome liner little of this is apparent, but it is always known to the crew, and rare indeed is the time on a steamship when repairs are neither under way nor contemplated.

This continuous round of repairs does not mean, though, that the steamships of to-day are not properly designed and built. It only means that a great ship is so vastly complicated that some part of it is always just a bit below par. A small town needs repair men to keep its electric-light system properly working. Its water system is similarly under constant supervision. Its gas, its paving, and a dozen other parts of its equipment are always being repaired, renewed, or extended. The same is true on board ship, except that, at least on the giant liners, the ship's equipment is more complicated than the town's.

This wandering discussion presents a few of the difficulties that face the designer, the builder, and the operator of ships. Such difficulties are all but infinite in number, and constant vigilance is vital to the efficient operation of the ships of to-day. But so reliable have these great structures grown to be that one of the greatest—the *Mauretania*—while launched in 1907, was able for twenty-two years to hold the transatlantic record, defeating newer ships of greater size and greater power in her constant voyages to and fro across the Atlantic. Such results as this must be credited to the designer, the builder, and the officers and crews of these complicated structures of the sea.

CHAPTER XIII

SHIPPING LINES

THE development of ships has been largely influenced by competition. The ship that can make the quickest voyages can demand the highest freight rates for most things. Furthermore, a fast ship can make more voyages than a slow one, and the owner may make a greater profit because of the greater amount of freight handled. These factors, and others less evident, enter into the operation of ships.

To-day great shipping lines control most of the earth's merchant ships. As we know these lines they are a growth of hardly more than a hundred years, but thousands of years ago their counterparts existed.

Phoenicia was the greatest trading nation of the ancient world. Ships sent out by the traders of Phoenicia sailed to every corner of the Mediterranean, and even went out into the Atlantic, where they braved the rough waters of the Bay of Biscay and sailed up the English Channel on their adventurous trading voyages. For every ship that sailed to distant parts, however, many remained nearer home, visiting ports but a little distance off, and returning with less romantic but equally important cargoes.

Many merchants of Tyre, of Acre, and of Sidon were ship-owners. Some sent their ships to Egypt, some to Greece, some to Sicily and Italy, some to the Bosphorus and the Black Sea. Some traded with Cyprus and the Ægean Isles, some with Asia Minor. Some again sent their ships to the Adriatic. It was only a few who risked their ships and

cargoes on those long voyages to the ends of the world, out beyond the Pillars of Hercules, and north along the tide-washed coasts of western Europe to where the days were far longer in the summer than the nights, and where the winter nights left but little of the day.

Naturally, the traders who were successful built other ships, and sent them in the same trade that had made their fortunes, for that was the trade they knew. If a ship-owner had had great success in sending his ships to the Bosphorus, the natural thing for him to do with any new ships he might build was to send them there. When he died and his son came to rule over the destinies of his business, what would be more natural than for him to continue to send his ships to the same part of the world?

Naturally, the frequent wars of ancient times upset the plans of merchants even as wars upset such plans to-day, but barring such unfortunate events, trade went on in the more or less even tenor of its ways, save for rather numerous difficulties caused by pirates and by storm or shipwreck.

One can almost imagine Tyre and Sidon with their streets of merchants' houses, over the doors of which, if they were given to the modern idea of signs, which is unlikely, hung shingles reading "Ithobal and Son, Traders to the Bosphorus and the Euxine." "Assurbani-pal, Ship-owner and Trader to the Valley of the Nile." But whether or not their places of business were decorated with such signs, their warehouses were full, and ever and anon their ships departed and returned, laden with goods of value that they carried across the seas.

Properly enough, then, some of these old traders may be considered the operators of some of the very earliest shipping lines.

One can almost imagine some old and experienced trader talking solemnly with the builder of his ships.

“Tuba’lu, my friend,” one can think of him as saying, “that last galley thou builtest for me was all but lost while on her very first voyage to the Bosphorus. Tiglath, her captain, tells me that just as he passed the rocks that lie off the island of Chios, a summer storm, not great, but rather sudden, smote him. His ship was so distressed by it that he all but gave himself up for lost. He has told me that, had his prayers to the gods to end the storm availed him not, most certainly would he have been dashed to pieces, and all my cargo of precious wares would have been lost. He tells me that the ship is not fit for storms, and that had he not, by the goodness of the gods, been favoured by good weather for all the rest of his voyage, he could never have returned with his cargo, which has made for me so good a return upon my moneys. What thinkest thou of the ship?”

“My good friend Ithobal,” the builder of ships might be supposed to have replied, “methinks the ship was just a bit too deeply laden when she left Tyre. So deeply did she lie upon the waters that I warned Tiglath against the very danger that he later came upon. Yet did he heed me not, saying that to make moneys for his master he had need to carry many goods.”

“And so he has, Tuba’lu, my friend,” Ithobal might have replied. “My ships must carry many goods to make profits for me on such long and dangerous voyages.”

“Then, Ithobal, my friend,” the ship-builder possibly replied, “but let me raise her sides by a cubit and mount upon her stern a larger steering oar. Methinks her safety will be then assured.”

So it might be supposed that ships were improved in those far-distant days.

Traders similar to those of Phœnicia were common in Greece, in Carthage, in Rome, in Venice, and Genoa, and in other ports for thousands of years. Until the introduction

of machinery and the use of steam power for manufacturing goods the cargoes of ships were limited largely to valuable goods taking up but little space, and so such methods were efficient enough, especially as the purchasing power of the masses was small, and their necessities were almost entirely homemade.

The period following the 11th Century showed some increase in the amount of freight handled, and a result of the discovery of America was to enlarge this still more. Still, however, the greater portion of the population of European nations had simple wants and simpler pocketbooks, and not for another three hundred years did the mighty purchasing power of great numbers of people begin to make itself felt in a demand for imported goods.

With the introduction of machinery, however, and especially with the introduction of steam, the workmen found it possible to purchase what had theretofore been unthinkable luxuries, and the demand for imported goods grew enormously.

The East India Company was an early concern in this new epoch of world trade. In 1600 this organization was founded and, by government charter, was given a monopoly on trade to the Far East. Because there was no competition this company grew fabulously rich, bringing to Great Britain wonderful cargoes of goods not securable except in India and China. This, however, was but a greater attempt at trading, and except in size and in organization was not greatly different from the methods in vogue two thousand years before.

It was not until the 19th Century that shipping lines as we know them came into existence. Actually it was the steamship that brought about the introduction of shipping lines, although the famous old packet lines that ran between Europe and America went by the name of lines several years before the first steamship line was organized. The first of these packet lines was the Black Ball Line, which was

established in 1816. So successful did this line become that it was followed within the next few years by several others. The Red Star Line, the Swallowtail Line, and the Dramatic Line were some of the most important. Winter and summer the packets operated by these lines raced across the Atlantic, sailing on scheduled dates, and making remarkably short passages, and giving remarkably good service for the times. The ships were not large, some of them being hardly more than three hundred tons burden, but for the first ten years of the Black Ball Line's existence the ships of that line averaged twenty-three days for the eastward passage and forty days for the westward, which was much lower than the average of other ships of the time. These packet lines continued in operation until about 1850, when they had largely faded from the sea, unable to compete with the steamships then becoming reliable, comfortable, regular, and fast.

The first steamship line to organize was the City of Dublin Steam Packet Company, which began operations in 1823. During the following year the General Steam Navigation Company was incorporated, and several other British steamship lines followed rapidly. At first these were for the coasting trade, where the regular service they maintained was valuable in the extreme, for railroads had not yet appeared. Before long, however, these lines began visiting the continent, and the transatlantic voyages of the *Savannah* in 1819 and the *Royal William* in 1833 drew the attention of steamship-builders and operators to the advantages of transoceanic routes.

In 1837 three companies were organized—the British and American Steam Navigation Company, the Atlantic Steamship Company, and the Great Western Steamship Company. In 1838 their first ships sailed to America. The *Great Western* made her first crossing in 13 days and a few hours, almost equalling at her very first attempt the fastest voyage

(and that from America to Europe) a sailing ship ever made. Brave as was the start made by these three lines, however, they soon went out of business.

It is probable that one of the most serious blows they received in their short periods of activity resulted from the success of Samuel Cunard in securing from the British Government the contract for carrying the mails from Liverpool to Boston and Halifax. This contract, which included a fairly sizable subsidy, required that Cunard build and operate four steamships, which the subsidy enabled him to operate successfully despite the competition of the other three lines. Cunard's steamers, being all alike and of very nearly the same speed, and being despatched at regular intervals, soon took from his competitors the little business they had, and they went out of business or transferred their ships to other duties.

The Cunard Line, then, from the Fourth of July, 1840, when the *Britannia* sailed for Boston, has been a successful transatlantic line, and is to-day the oldest transatlantic line in existence, as well as one of the finest and most powerful. At first this company was known as the "British and North American Royal Mail Steam Packet Company," and its first ships, the *Britannia*, the *Acadia*, the *Caledonia*, and the *Columbia*, were each 207 feet long, about 1,150 tons, and could carry 115 cabin passengers and 225 tons of cargo.

In 1840 the Pacific Steam Navigation Company obtained its charter and was the pioneer steamship line along the western coast of South America. Earlier than this, however—in 1835—a firm of London merchants began to run steamers from England to the Far East. These steamers, sailing more regularly and with more dispatch than the sailing vessels, were given the contract to carry the mails. This service became the Peninsular and Oriental Steam Navigation Company, which is still a vigorous and enterprising line,

although now it sails out and back through the Suez Canal and not by the long route around the Cape of Good Hope.

One of the two oldest existing steamship lines is the General Steam Navigation Company, which I have already mentioned. Founded in 1824, this line still runs steamers from England and Scotland to the continent and the Mediterranean. In 1846 one of its ships—the *Giraffe*—carried the first cargo of live cattle to England.

While the Allan Line has operated steamships only since 1852, it may be said to have been founded about 1816, when Captain Alexander Allan began running several sailing vessels between Scotland and Canada. Although this line did not adopt steamships until thirty-six years after it was founded, it has had a leading place in the development of steamships. An Allan liner inaugurated the "spar deck" in order that a clear promenade deck might be constructed. The first Atlantic steamship to be built of steel—the *Buenos Ayrean*—was an Allan liner built in 1879. The *Virginian* and the *Victorian* were built in 1905 and were the first transatlantic steamships propelled by turbines. Such developments as these entitle a steamship line to great credit.

The largest privately owned shipping company in the world is the Wilson Line, and it is also one of the oldest. It traces its beginnings to 1835 and operates ships between Great Britain and Scandinavia as well as between Britain and the Far East, and to the United States. It also operates ships to South America and other parts of the world.

The World War radically affected steamship lines, almost eliminating some and crippling many. The peace brought about the enlargement of several at the expense of the German lines that, during the preceding two decades, had thrust their way to the very forefront of the shipping world, only to lose it all by the terribly mistaken policies that they themselves had helped to foster.

In 1900 the two greatest steamship lines in the world were the Hamburg-American and the North German Lloyd. In 1910 they were surpassed only by a consolidation of seven British and American lines known as the International Mercantile Marine. Yet these two huge companies, at the close of the World War, were left with hardly more than a handful of ships each, all of their greatest liners, as well as most of their smaller ones, having been taken from them to sail under the British, American, French, and other flags.

Consequently, the greatest steamship company to-day—and it is so great as to have no close second—is the International Mercantile Marine, made up of the White Star, the Leyland, the American, and the Atlantic Transport lines, the Dominion and British North Atlantic Company, the National Steamship Company, and some other allied shipping interests.

This combination of shipping lines is controlled by British and American capital, but most of its ships sail under the British flag. American shipping laws are partly responsible for this, because of numerous restrictions they insist upon, which have proved to be detrimental to lines operating ships under the American flag. Other lines, entirely American owned, have been transferred to foreign register for the same reason.

Prior to the World War American deep-sea shipping had shrunk to a woeful degree, and most of America's imports and exports were carried in foreign ships. The war, however, changed all that, and the United States, in a remarkably short time, had built ships enough to place it second only to Great Britain on the sea. Many of these ships were hurriedly and badly built, it is true, and many ridiculous experiments were tried out, but, despite mistakes, a great merchant fleet was built and put into operation. This, of course, was a war measure, but with the signing of the Armis-

tice America set herself the task of operating this huge fleet. Post-war trade, however, did not call for so many ships as were in operation, and vast fleets of ships were tied up to deteriorate in idleness. Not only America suffered. Great Britain, too, found herself with more ships than cargoes, and all over the world ships were tied up to wait for better times or to fall to pieces in the waiting.

This unfortunate condition, however, was not entirely without advantages. It forced economies in operation that resulted in increased efficiency, for ships could only continue to carry cargoes if they did so at low rates, and the shipping lines, therefore, studied every method by which they could reduce their costs of operation.

This, of course, brought about many rearrangements. Some formerly successful lines went bankrupt. Many new and inexperienced lines disappeared. Many masters and mates found themselves ashore without work, forced to take employment at whatever tasks they could get. But new lines did make their way, and most of the experienced lines managed to hold on, even going into new fields, as the practical elimination of the German lines gave them some opportunity to do. And following the war, American ships became known in ports where the American flag had not been seen for a generation or more.

This probably means that America is on the seas to stay. No longer do internal developments take the attentions of the entire nation. The growth of manufacturing, the lack of wide public domains open to the "homesteader," the widespread American interests overseas, all point to a permanent merchant marine, not, perhaps, so great as is Great Britain's, because America is not so vitally dependent on the sea as is Great Britain, but great because America is great, and growing because America is still developing.

In this development shipping lines are the vital factors.

Individual ships are merely pawns on a world-wide chess-board. A single ship can do nothing in the complex structure of modern commerce. Lines must maintain regular service. They must maintain home and foreign offices. They must know where cargoes are to be had and where they are to go. They must have armies of agents and brokers constantly in touch with them. Their ships must be able to voyage and return, voyage and return again, always filled, never idle, never at a loss for cargoes, else their costly structures will crumble, their finances wane, and they will find themselves faced with bankruptcy, disruption, reorganization or destruction.

Because of world economics shipping lines find it possible to develop or find themselves broken. Because the margin between success and failure is usually a narrow one shipping lines find it essential to seize upon every development that increases efficiency and decreases cost. Simple steam engines became compound, because shipping lines had to operate their ships with a smaller outlay for fuel in order to compete with sail. Iron gave way to steel, because greater strength was thus secured with less weight. The turbine has made its way against the reciprocating engine because of its increased efficiency and its consequent saving in expense. Oil is being more and more widely burned instead of coal, because its efficiency makes it cheaper through the use of fewer men, through increased steaming ability and less weight, as well as its cleanliness (on passenger ships) and the reduction in time used in coaling.

Shipping lines are very similar to railroads. A railroad train would be of no use to any one if it were owned and operated as a unit, even though it had all the tracks in a nation at its disposal. The train is practical only because the railroad company maintains freight and passenger stations, foreign and domestic agents, and all the detailed

force that a modern railroad requires. Furthermore, it sends its trains over certain routes at certain specified intervals, ready to move freight and passengers as they are ready to be moved. So must a shipping line be operated. Ships must be where they are needed, else freight accumulates or is diverted to other lines. The huge investments ships require necessitate that there be no loss of time and consequently ships must not wait for freight to come to them. Because ships carry great amounts of freight and cannot lengthen or shorten themselves, as trains can, to accommodate fluctuating quantities, it is often necessary for freight to go in "tramp" steamers to ports which attract small amounts of freight. But cargoes must be waiting at those ports for shipment to some other or the ship loses time and the line loses money. Because of this agents are for ever busy, cablegrams are for ever being flashed through the ocean depths, or ships are diverted by wireless in order to take advantage of temporary conditions.

These are the duties of shipping lines, and the vast companies of the modern world of the sea are amazingly capable, brilliantly alert, for ever in touch with shifting channels of trade, alert to fill the needs of a busy world that pays them only for the service it demands.

Perhaps the fierce competition of to-day seems harsh, yet it is constructive. Perhaps it bears too heavily upon many deserving individuals, yet through it has come about the vast improvement that has marked the shipping world in the last hundred years—an improvement that has shortened voyages, limited the time between continents, reduced the very world until voyages around it are now almost commonplace summer holidays.

Without competition the old East India Company sent its ships from England to the East for 300 years, and served Britain little better at the end of that time than at the begin-

ning. With competition the transatlantic voyage has been cut from forty days to little more than four. Giant ships plough every sea and offer their magnificence to every passenger who cares to pay the passage money. No longer do silks and spices fill the holds of the argosies of the deep. Iron ore or polished motor cars, bales of cotton or crates of textiles, toys or machinery, hides or shoes, lumber or furniture—it matters not. Given only a place of origin and another place overseas where buyers wish it delivered and ships there will be to carry it. There is not a single harbour between the eternal ice of the two polar seas that is not visited by ships. There is not a person of the billion and a half who inhabit the globe but is affected by them. The natives of Central Africa buy cotton goods made in England of cotton grown in Alabama. The Eskimos of the frozen north hunt for seals with guns made in Connecticut. Oil that gushes from the rocks of Transcaucasia is refined, and burned in motor cars as they roll along the Champs Élysées. Copper from the Andes is made into roofing for houses everywhere on earth. Toys made in Czechoslovakia or Japan fill the counters of the toyshops of Britain and America.

No longer do oceans divide the world. As shipping lines continue their development they cannot fail to weld the world into a vast economic unit, interdependent and friendly, useful to one another and to unnumbered generations of the future.

To-day we look back to the beginnings of the shipping lines and smile as we think of their trifling activities. In a hundred years they have grown from infancy to vigorous manhood, but their future will not be one of senility. Instead, as years go by, their growth will greatly continue, and a hundred years from now the point of view of our children's children will probably be to the shipping lines of to-day what ours is to the lines of a hundred years ago.

CHAPTER XIV

THE IMPORTANCE OF SHIPS

SINCE time immemorial man has sailed the sea, yet is the sea but little known. To most of us it is an engima, even though we may often have viewed its undulating surface from the deck chairs of ocean liners. But the ocean is not to be learned by idling passengers in deck chairs. One must play a part—no matter what—in the struggle to master it before one may feel acquainted with it. Nor even then may one become familiar, nor trust it over much. Sometimes it rages loud and long, and finally, worn out with the strain of raging, goes into a sort of restless doze, with occasional reawakenings of anger. Sometimes it hides beneath a mask of fog—quiet but untrustworthy, motionless but sulky—giving out no warnings of its dangers, and stubbornly interfering with those that man sends out. But these are not the moods most natural to the sea.

Its moods are generally genial. Sometimes it lies for days, untroubled by its storms, unhidden by its fogs. All day its surface twinkles in the sunlight or all night rocks the bright reflection of the moon. It winks and smiles and whispers to the sides of every passing ship. Its sounds are sibilant and liquid. Or it may be playful, leaping joyously in great blue surges, through which the sunlight gleams. Now and then, perhaps, a wave may pop an inquisitive crest a little above the rail, and sprinkle sparkling drops of salty water over a sailor or a passenger, but one need only look down beside the ship and see the colour of the waves to know that therein lies only virile playfulness.

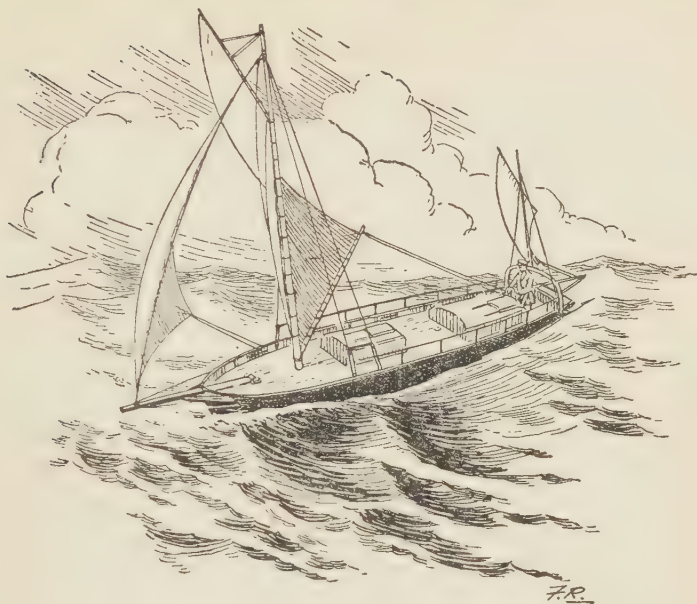
And these are the more usual of the moods of the sea. Now and then it turns gray with anger and flings itself about in fits of fuming rage. Now and then it glowers beneath the fog, ugly and menacing. But in that, as in its sunny gentleness and boisterous fun, it has only the attributes of many a child—quick to foolish anger, quick to sullen sulking, but just as quick to gentleness and fun, and much more given to them.

But the sea, unfortunately, is generally judged by its moments of petulance. It is generally the story dealing with storm or fog that finds its way into the papers. In that we react toward the sea just as we do toward our neighbours' children. Weeks may pass during which they are guiltless of a single childish prank and we are likely not to think of them at all. But let them tie a tin can to our old dog's tail or run our cat high up among the branches of a tree, and we are likely to be loud in criticism of them.

And so the sea. It periodically, so to speak, ties tin cans to the tails of even the biggest ships. It sometimes drives badly treated vessels into the protecting reaches of our harbours. But for every traveller who has seen a storm at sea there are a hundred who never saw one, albeit many of these latter, because the ship may have rolled a bit too much to suit their untrained stomachs, would swear that they had passed through storms of the very greatest magnitude.

But storms, by and large, are not so serious as landsmen sometimes think. This is proved by the numerous long ocean voyages that have been made—that are constantly being made, as a matter of fact—by small ships, by yachts, by tiny sailboats, even by open rowboats, all over the world, and often for pleasure.

In 1896 two young Americans left New York in a small light rowboat, without sails or engine, and sixty-two days



THE SPRAY

In which Captain Joshua Slocum circumnavigated the globe.

later landed at Havre, France, having rowed the entire distance—aided, of course, by the Gulf Stream Drift and by the fact that the prevailing winds were from astern. Such a trip is foolhardy in the extreme and proves nothing except that there are people foolish enough to do even so nonsensical a thing.

In 1849 a 41-foot sailboat sailed from New Bedford for San Francisco—a 13,000-mile voyage around Cape Horn, the most notorious cape in the world—and in 226 days had arrived at her destination.

In 1877 a man and his wife sailed a 20-foot decked whaleboat from New Bedford to Penzance, England, in forty-nine days. In 1878 a certain Captain Andrews and his brother

sailed from Boston to England in a boat only 15 feet 6 inches long. They made the crossing in forty-five days.

Captain Joshua Slocum is famous among small-boat sailors. He made a voyage of 5,000 miles from Brazil to the United States in a 33-foot decked dory built from material salvaged from a wrecked ship. Later he sailed alone around the world in the 37-foot yawl *Spray*, on a voyage that occupied three years and two months. Captain Voss, a Canadian, sailed 40,000 miles in a 40-foot Alaskan war canoe which he had decked and otherwise prepared for the voyage. In 1911 Captain Thomas Fleming Day and two companions sailed the 25-foot yawl *Seabird* from Providence, Rhode Island, to Gibraltar in thirty-seven days including a five-day stop at the Azores. In 1912 the same Captain Day, with another party, took the 35-foot motor cruiser *Detroit* from Detroit, Michigan, to St. Petersburg, Russia. In 1921 Alfred Loomis and some friends sailed a 28-foot yawl from New York to Panama. Nor have I listed more than a fraction of the small boats that have crossed wide stretches of open ocean. That such voyages are not so ridiculous as many people unacquainted with the sea believe is proved by the valuable services rendered by the British motor launches during the World War. These 60- and 80-foot motor boats patrolled the rough waters of the Irish and North seas and the English Channel throughout the long submarine campaign, and America, as I have said before, in 1917 and 1918, sent shoals of submarine chasers, each but 110 feet in length, across the Atlantic to England, Ireland, France, the Mediterranean, and even to the Arctic coast of Russia, all without the loss by shipwreck of a single vessel. Yet despite all this evidence that proves the seaworthiness of small vessels and proves, too, the essential kindness of the sea, most people ashore think of long voyages in small boats as being foolhardy and suicidal.

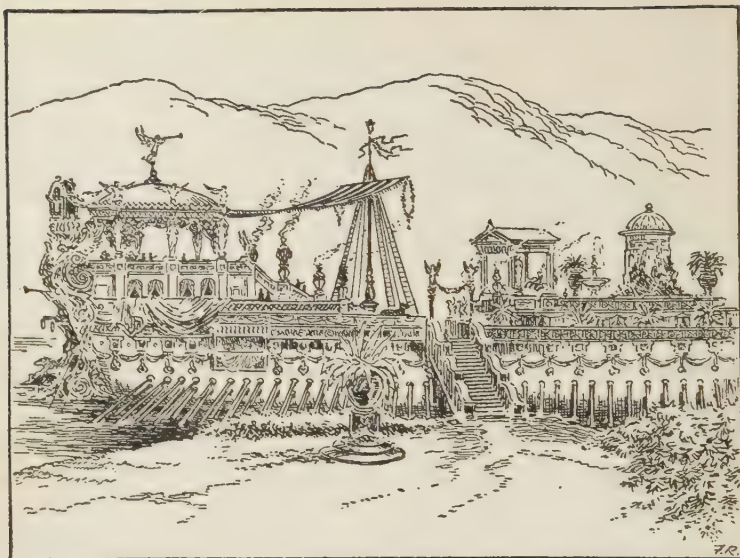
Of course, many such voyages have been foolhardy, and some have been suicidal. But to the person who knows the sea and who knows boats such voyages need be neither the one nor the other. A properly designed and constructed small boat well handled is not likely to founder. When carelessness or lack of information enters into either the designing, the construction, or the operation of such a boat the result may be different, although the sea, being usually in kindly mood, allows many such to pass unscathed.

In 1922 A. Y. Gowan sailed a 98-foot motor cruiser around the world. That the boat was not designed for such a voyage is proved by the fact that her gasolene capacity was not great enough to permit her to make the longer jumps



THE DETROIT

This 35-foot motorboat made the voyage from Detroit, Michigan, to St. Petersburg, Russia.



A RECONSTRUCTION OF ONE OF CALIGULA'S GALLEYS

This luxurious ship was built on Lake Nemi, Italy, during the reign of the Emperor Caligula (37-41 A. D.). It sank to the bottom at some unknown period, and has often been examined by divers, for it is still in a fair state of preservation. It is 250 feet long, and its equipment was of the most luxurious kind. Suggestions for its recovery have been made, and it is possible that the lake, which is a small one, may be drained in order to study this old ship and another one that is lying near it.

between ports entirely under her own power. This necessitated tows, and for many a weary mile of the way she wallowed and jerked at the end of a towline. Yet this yacht, intended though she was for protected waters, made the voyage, although she must have been uncomfortable to a degree in rough weather. This voyage proves that with a little thought, in these days of weather reports and compiled data on prevailing winds and stormy seasons, a small vessel may lay her course so as to avoid the most serious bad weather—barring, of course, local storms that do, sometimes, attain great ferocity. It is well known, for instance,

that during the summer months the North Atlantic is generally mild while during some of the winter months it grows exceptionally boisterous and ugly. Therefore the small boat that would cross it had best choose the summertime. Should Mr. Gowan's little yacht ever find herself in the grip of a really serious North Atlantic winter gale she would run a most excellent chance of never seeing pleasant weather again. Yet, as I have said, a tiny rowboat crossed this very stretch of water in the summer of 1896.

All of this merely means that good judgment, based upon experience and compiled information, is about the most valuable bit of sea-going equipment that the deep-sea small-boat sailor can have. Nor does that apply only to small-boat sailors. Nor, again, is it always necessary for the sailor, merely because his boat is small, to feel that he must stay in port in heavy weather or founder if it come upon him



A EUROPEAN SIDE-WHEELER

These steamers are often seen in European waters and are widely used as excursion boats.

while he is on the sea. Not by such a doctrine have the fishermen of Gloucester made for themselves the reputation that they have. Summer and winter they take their schooners out to the Grand Banks and live out the greatest storms that try those storm-tossed waters. From the deck of a 50-foot Gloucester fisherman I have seen the seas tower high before her bow, seemingly about to crush the craft, and have seen the mighty troughs, which, from the crests of the great seas, seemed abysmal in their depth, yet did the little vessel ride through them without so much as a splintered rail. These schooners come in loaded with fish and often encrusted with ice. It is true that their sails are sometimes split, their masts sometimes swept overboard. Yet is the fatality among such vessels light, despite the fact that they face most of the storms that blow each winter on the Banks.

Ships Had it not been that small boats can safely sail the seas it is difficult to see how we ever could have arrived at the era of great ships. Ancient history tells us of ships that, at least until the prime of Greece and Rome, could not by any stretch of the imagination be called large. Yet the old ships of the Phoenicians sailed, even before the days of Greece, all over the Mediterranean, out into the Atlantic, as far north as the English Channel, at least, and on one occasion, around Africa. Then came Greece, and ships grew somewhat in size. Then Rome appeared, and ships grew larger still, although most of them still were small, as always. By the time of Caligula (37-41 A. D.) Roman shipwrights had greatly increased the size of their large ships, as is proved by a ship now resting on the bottom of Lake Nemi in Italy.

During and following the Dark Ages ships had again become small, and only gradually did they enlarge. Even by the time of the Spanish Armada a ship of 1,000 tons was

considered huge. Yet such ships, as I said, were considered very large, not more than a handful of the more than three hundred ships in the Armada and the British fleet opposing it approaching such a measurement, and hardly more than three or four exceeding it. Among the 197 British ships that opposed the Armada but seven were more than 600 tons.

Even at the beginning of the 19th Century ships of a thousand tons or more were rare, and the famous clipper



A HUDSON RIVER STEAMER

The passenger steamers of the Hudson are large, speedy, and are capable of carrying thousand of excursionists.

ships of even a later period were smaller almost as often as they were larger. Yet did these ships speed on their way across the oceans in all weathers in their furtherance of trade.

Of the billion and a half people who inhabit the world to-day few indeed appreciate the huge importance of ships.

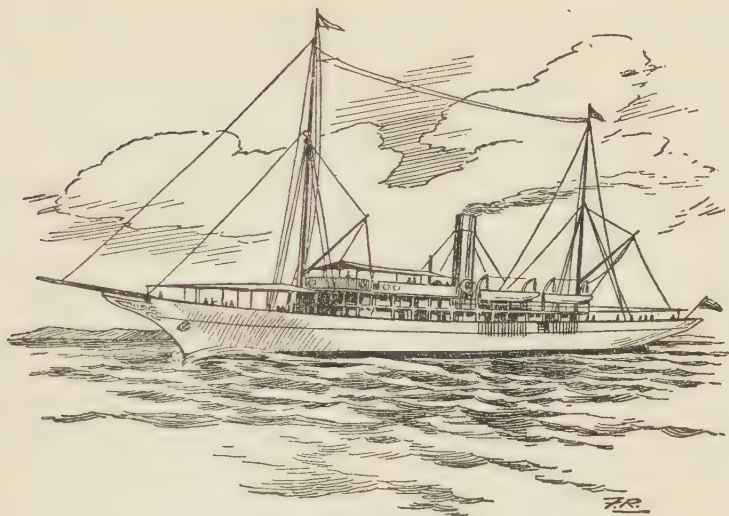
As I pointed out in my opening chapter, the world as we know it could not exist without them. Even the far simpler world of the ancients required them, and the modern world depends on them far more.

Re. Rice

In Great Britain there is a wide and real appreciation of the value of merchant shipping. But the fact that Britain is an island depending upon lands across the seas for the very food that gives it life makes the importance of ships more evident. Not only for that, of course, are ships vital to Great Britain. To buy food her people must manufacture goods to sell to foreign peoples. Does the manufacturer weave textiles? His raw materials come from the United States, from Egypt, from Australia and New Zealand. Does he manufacture tires? His raw materials must be bought in the East Indies and Egypt. Does he manufacture cutlery? His product, or at least much of it, must be sold in foreign markets in order that such foreign products as are not to be found in Britain may be purchased. Does he need oil? He must buy it from the Dutch East Indies, from Transcaucasia, from America. Do the people need sugar for their tea? It must come from Cuba or Jamaica. Does the country need copper? It may come from Peru or Michigan. Furs? From Canada. Wheat? Argentina. Canada, Australia, the United States, Russia. Coffee? Brazil or Java. Rice? Japan, the Philippines. Lumber? Canada. Paper? Canada or Scandinavia.

And for every cargo bought in foreign lands a cargo should be returned, else trade is unhealthy and will languish. Britain, to a large extent, imports raw products and food, and exports manufactured articles and coal. This the people know and deeply realize. The result is that Britain's merchant fleet is the greatest the world has ever seen.

But in the United States the vital importance of ships is



A STEAM YACHT

Unfortunately the type of yacht pictured here is less common than formerly. These are being replaced by yachts with less graceful lines, differing from this in many respects but perhaps most noticeably in having a perpendicular bow and no bowsprit.

not widely understood. During the last decade of the 19th Century and the first one of the 20th it might almost have been said that the subject was not understood at all. The World War corrected that somewhat, but even after that holocaust had forced the subject before the public and had created a condition that demanded ships, the subject was not more than superficially grasped. The result was that the nation that had suddenly leaped to a position in world shipping second only to Great Britain so lightly took its responsibilities that its great fleet of ships was permitted to run down when an economic crisis made it impossible for them to find cargoes. Almost as important in this deterioration of the American Merchant Marine after the war were the backward laws and lack of interest on the part of the people.

But the United States is not so situated that the importance of ships can easily be appreciated. The people would not starve if there were no ships, for the nation's own resources, seconded by those of Canada, would prevent such a calamity. The land has coal and steel, has copper and cotton and farm products. It *could* have enough sugar without going overseas. Its great area and diversity of climatic conditions produce, perhaps, more of the necessities of life than can be produced by any other single nation. Yet is it dependent upon ships. Without them the millions of automobiles would shortly stop running—for lack of rubber, from which to make tires and insulation. Without ships the vast wheat crop could only with difficulty be harvested—for lack of binder twine, which is made from Yucatan sisal.

These imports are vital and there are others equally so, besides thousands without which we could get along, but less comfortably. Coffee and tea, spices, silk, diamonds (not merely for jewellery, which is unimportant, but for industry in which vast numbers of them are essential to many processes of manufacture), chocolate, fish (or at least most of them), many metals necessary to industry, ingredients for many important drugs and medicines, mahogany and other fine woods which are vital for more than furniture, and a thousand other things that now are a part of everyday life.

The high standards of living now commonly accepted by the people of the United States would be greatly lowered were it not for the ships that bring to its ports the products of foreign lands and take away the country's excess food products and manufactured and raw materials bought by those foreign lands.

Nor, as the World War showed Americans, is it wise to depend upon foreign nations to transport all their products

to America and carry all America's products away. To be healthy the nation should maintain its own cargo fleet, which, in turn, should provide itself with terminal facilities not only at home but also abroad, in order that cargoes may be loaded and unloaded economically and without delay. America has passed the era in which the interior development of the nation utilized all the energies of its ambitious population. Already it has stepped into the field of foreign commerce in which it must now continue. Time was when the nation's interests lay entirely at home, but that time is no longer. Increasingly will America's exports be a factor in foreign markets, and upon this depends to an ever-growing



THE MOTORSHIP AUGUSTUS

To the casual observer this Italian ship presents no new features, yet she belongs to the new class of Diesel-driven vessels that already have made enormous progress though the first of them was built only a few years before the World War. Today they seem destined to overcome steam as steam has overcome sails.

extent the welfare of Americans. Time was when the land was the producer only of raw materials. Now it is one of the world's greatest manufacturing nations, with an infinite number of products that cannot be consumed at home.

Ships, then, must become a growing interest of Americans, for upon ships, and largely upon their own ships, must they depend to maintain the standards of living that have made Americans the most fortunate of the peoples of the world.

Whether it be the citizen of New York or of San Francisco, of the mountain states or of the prairies—whether it be the clerk, the farmer, the manufacturer, or the ranchman—whether it be the millionaire or the day labourer, the teacher or the business man, still should he interest himself in ships, for only upon a wide appreciation of their value can wise legislation be built, and only with the support of the people can great fleets be maintained to carry the nation's products to other lands and return with those vital cargoes upon which the nation's comfort and happiness are so largely built.

THE END

APPENDIX

APPENDIX

An abridged dictionary of nautical words and expressions

I am anxious that it should not appear that I believe the following list to be either complete or adequate. The phraseology of sailors is often so saturated with nautical expressions that a person uninitiated into the fraternity of the sea might easily find their conversations almost beyond his comprehension. The words that follow, however, and their definitions, will make clear any portion of the text of this book which may have more of a nautical flavour than I intended, and may, too, clarify other things in the minds of those unacquainted with the language of the sea.—H. D.

a—An Anglo-Saxon prefix for “on” or “in.” It is in constant use at sea, as in *aback*, *aboard*, *astern*, etc.

aback—Spoken of square sails blown back against a mast by a sudden change of wind, or, in some instances, put in that position purposely for some special purpose.

abaft—Behind or toward the stern of a vessel. Thus, *abaft* the bridge will mean toward the stern from the bridge.

abeam—On the side of a vessel, amidships. Thus, an object *abeam*, or *on the beam*, is an object at right angles to the vessel amidships.

aboard, or **on board**—On, or in, a vessel.

about—A turning round. To go *about*—To turn a vessel round, in sailing, so that the wind comes over the other side. See *tack*.

adrift—Anything which floats unfastened, as a boat or a spar, which may have broken away, or a ship which has parted from her anchor. Seamen also refer to articles carelessly lying around a ship as *adrift*.

aft—Behind; toward the after or stern part of a vessel. Thus, the poop deck is *aft*.

alee—To put the helm *alee* means to bring it toward the side of the ship away from the wind. This heads the boat into the wind, or, if the helm is kept *alee*, brings her about.

aloft—Up in the tops—overhead. In the upper rigging, or on the yards, etc.

alongside—By the side of.

amidships—Generally speaking, the middle portion of a vessel.

anchor—A metal hook specially designed to take hold of the bottom in comparatively shallow water. A cable connecting the anchor and the ship makes it possible for a ship to maintain her position against wind or tide or current. Anchors are of many shapes and vary in size from a few pounds to a number of tons.

anchorage—A section of a harbour or a roadstead where ships may anchor.

aneroid—A barometer which is operated by the pressure of the atmosphere on a metal disc covering a partial vacuum. The varying pressure operates the hand on a dial, and this is graduated to the same scale as is a mercurial barometer.

artemon—A sail used on Roman ships. It was square and was mounted at the bow on a kind of mast that leaned over the bow. Later its place was taken by the spritsail.

astern—Behind. In the after part of the vessel; behind the vessel; in her wake.

astrolabe—An instrument of the late Middle Ages with which mariners attempted to learn their latitude. The instrument was very imperfect in its workings.

astronomical ring—An instrument that was meant to improve on the astrolabe, but which was just as inaccurate.

athwart, athwartships—Across. Hence the rowers' seats in an open boat are called thwarts because they lie *athwart*, or across the boat. To drop *athwart* anything—To come across it; to find it.

auxiliary—A sailing ship equipped with an engine for use in emergency or in crowded waters is said to be an auxiliary. Sometimes sails are carried on power-driven vessels for use in case it is desirable not to use the engine or in case of breakdown. In this case also the ship is an auxiliary.

avast—The order to stop or pause in any exercise; as, "*Avast heaving.*"

aweaether—Toward the weather side; *i. e.*, the side upon which the wind blows.

aweigh—Spoken of an anchor when it has been lifted from the bottom.

aye (*adv.*, perhaps from *ajo*, Lat. (defective verb), to say yes)—Yes; always used in lieu thereof at sea, with a repetition, “*Aye, aye, sir,*” meaning, “I understand; and will execute the order.”

back—With sailing ships: To *back* a square sail is to haul it over to windward so that the wind blows it against the mast. With steam vessels: *Back* her is an order to reverse engines, so that the ship may be suddenly stopped or made to go astern.

back-stays—Ropes stretched from a mast to the sides of a vessel, some way aft of the mast, to give extra support to the masts against falling forward.

balance lug—See **LUG**.

bale, baler—To *bale* or *bale out* is to remove water from a boat by means of a *baler*, which may be any small container capable of holding water.

ballast—Weight deposited in a ship’s hold when she has no cargo, or too little to bring her sufficiently low in the water. It is used to counterbalance the effect of the wind upon the masts and give the ship a proper stability, that she may be enabled to carry sail without danger of upsetting, and is sometimes used in steam vessels to increase their stability or to correct their “trim”; that is, in order that neither bow nor stern will float too high.

balloon canvas, or press canvas—The extra spread of canvas (*i. e.*, sail) used by yachts in racing, generally, in a great sail often called a “ballooner.”

bank (of oars)—A tier of oars all on one level. In ancient oar-driven ships there were often several banks. All the oarlocks that were at the same distance above the water level mounted oars said to be in the same bank.

barbette—The heavy armoured foundation on which the turret of a modern battleship is mounted.

barge—A general name given to most flat-bottomed craft. In ancient and mediæval times the name was given also to large boats of state or pleasure, and in later days to one of the small

boats of a man-of-war. The barges of to-day are of various descriptions, being either sea-going, river, or canal.

barkentine—A three-masted sailing vessel, square rigged on the fore- and mainmasts, and fore and aft rigged on the mizzen. For illustration see page 201.

barometer—An instrument for measuring the weight or pressure of the atmosphere. A careful study of its changing record makes it possible to foretell many of the changes in the weather.

batten—A long strip of wood. Battens are used for many purposes, such as covering seams inside the hull. To *batten* down—To cover up tightly; usually spoken of hatches when they are closed tightly.

battle cruiser—A large and very powerful fighting ship, of high speed, and with an armament equal or superior to that of a battleship, but very lightly armoured.

beam—The width of a vessel at her widest part.

bearing—The direction, or angular distance from a meridian, in which an object lies.

beat—To *beat* to windward is to make progress in a sailing vessel in the direction from which the wind is blowing.

belay—To make fast; as, to *belay* a rope.

belaying pin—A movable pin or bolt of wood or metal to which lines are belayed.

below—To *go below* is equivalent, on shipboard, to going downstairs.

berth—A bed or bunk on board ship; a place for a ship to tie up or anchor is sometimes called a berth.

between decks or **'tween decks**—Any place below the main deck on a ship of more than one deck.

bilge—That part of the hull of a ship inside and adjacent to the keel.

bilge keel—Fins of wood or steel approximately paralleling the keel but built into and projecting from the ship at about where the bottom and the sides might be said to join. They are intended to minimize the rolling of the ship.

bilge water—Water that collects in the bottom of the ship. As this is always at the lowest part of the hull, oil and other impurities

are always a part of the bilge water, with the result that its odour is generally offensive and it is very dirty.

binnacle—The fixed case and stand in which the steering compass of a vessel is mounted.

bireme—An ancient ship, driven by two banks of oars.

bitts—Posts of metal or timber projecting from the deck, to which lines may be made fast.

Blackwall hitch—A knot. For illustration see page 193.

block—A pulley used on board ship.

boat—A small vessel. It is improper to refer to large ships as boats.

bob stay—A stay or rope made fast to the stempost of a ship at the cutwater and leading to the end of the bowsprit.

bolt-ropes—The ropes along the borders or edges of a sail for the purpose of strengthening those parts.

bonnet—A narrow strip of canvas laced to the foot of sails on small vessels to increase their area in light winds. More common in mediæval times than now.

boom—The spar at the foot of a fore and aft sail. There are other booms for other uses, such as a *boat boom*—a spar projecting from the side of a ship and to which small boats floating in the water are made fast when the ship is at anchor.

bow—The front end of a vessel. The *port bow* is the left side of the front end, and the *starboard bow* is the right side.

bowline—A knot. For illustration see page 193.

bowsprit—The spar projecting from the bow of a ship and to which the fore stays are led from the foremast. It is a highly important part of a sailing ship's rigging, but when used on power-driven ships, as it often is on steam yachts, it is more decorative than necessary.

boxing the compass—Repeating the points of the compass in order, starting from any point.

brace—Ropes on a square-rigged ship leading to the ends of the yards and used for the purpose of setting the yard at the proper angle to the mast are called *braces*.

breaker—A small water barrel.

breakers—Waves that curl over and break because of shallow water.

breakwater—An artificial bank or wall of any material built to break the violence of the sea and create a sheltered spot.

bridles—Several lines leading from a larger line to distribute the strain on an object to which they are attached.

brig—A vessel with two masts (fore and main) both of them square rigged. For illustration see page 201.

brigantine—Same as a brig except that it has a fore and aft mainsail. For illustrations see page 201.

broadside—The firing of all the cannon on one side of a warship at the same moment.

bulkhead—A partition of almost any material. Nowadays steel bulkheads are most common. Their purpose is to divide the ship, generally laterally, into separate compartments that, in the highest designs, are watertight.

bulwarks—A parapet around the deck of a vessel, serving to guard passengers, crew, and cargo from the possibility of being swept overboard.

bumboat—A small harbour boat allowed to visit ships in port and supply the sailors with various articles.

buoy—A floating marker intended as a guide or a warning. Buoys have been more or less standardized, but in many different parts of the world similar shapes and colours still stand for different things.

cabin—A habitable apartment on shipboard.

cable—The rope or chain by which a ship's anchor is held.

calking—Stuffing the seams of wooden ships with oakum.

can buoy—A buoy which shows above water the form of a cylinder.

canoe—A light boat propelled by paddles. Sometimes sails are also used.

capstan—A kind of windlass sometimes found on ships, and used principally for raising the anchor.

caravel—A ship commonly in use in the "age of discovery"; that is, during the 15th Century. Columbus's *Santa Maria* was one of these. For illustration see frontispiece.

careen—The operation of tilting a ship over to one side or the other by means of tackle led from her masts to points at some distance from her side.

- cargo liner**—A freight ship that sails on scheduled dates over a given route, as passenger liners do.
- carrick bend**—A knot. For illustration see page 193.
- carvel**—A method of small boat-building in which the board coverings present a smooth surface.
- catamaran**—A boat made up of two parallel and equal hulls held together by a framework.
- catboat**—A small sailing boat with one mast and a single sail which is generally similar in shape to the mainsail of a sloop. For illustration see page 203.
- centreboard**—A movable sheet of metal or wood sometimes used by small sailboats. It extends through the keel and presents a large surface to the water and tends to eliminate lateral motion while the boat is under sail. A kind of folding keel.
- chart**—A map of the sea and coast projections for use by navigators. Features of the bottom are also shown for shallow water.
- chronometer**—An accurate timepiece generally registering the time at Greenwich, England. Navigators require this instrument in working out their longitude.
- clinker**—A method of small boat-building in which the covering planks overlap as weatherboarding does on the side of a house.
- clipper**—A fast sailing ship suddenly developed in the first half of the 19th Century. Generally, but not necessarily, the clippers were full-rigged ships. They were popular for about fifty years. For illustration see page 63.
- cockpit**—See WELL.
- collier**—A vessel employed in the coal trade.
- companionway**—The entrance to a ladder or flight of stairs leading from one deck to the one below.
- compass**—A magnetized instrument which points approximately in the direction of the Magnetic Pole and from which directions can be learned.
- corvette**—A small warship of the late 18th and early 19th centuries.
- crossjack** (pronounced "cro-jak")—The square sail sometimes hung from the lowest yard on the mizzenmast of a full-rigged ship. It is not commonly used.
- crosstrees**—The arms extending laterally near the head of a mast

at right angles to the length of the vessel and to the extremities of which the topmast shrouds are stretched for the purpose of giving support to the topmast.

cruiser—A large, fast, and lightly armoured ship of war. The expression is also used in yachting, meaning a boat meant for cruising.

cutter—A sailing boat with one mast carrying staysail, jib, fore and aft mainsail, and sometimes a topsail. Other sails are also sometimes added. In various navies the expression is used to denote a large heavy rowboat propelled by as many as ten oars.

cutwater—That portion of the stem of a vessel that cleaves the water as she moves ahead.

davit—A light crane mounted on a ship's side and used for hoisting and lowering boats. Ordinarily two davits are used to each boat. The projecting beam over which the anchor is sometimes hoisted is also sometimes called a davit.

deck—The covering of the interior of a ship, either carried completely over her or only over a portion. Decks correspond to the floors and roof of a flat-topped building.

derelict—A ship adrift at sea without her crew.

destroyer—Formerly called "torpedo-boat destroyer." These ships are enlargements of torpedo boats and were originally designed to destroy those small, fast warships. They have proved very useful for many naval duties, and are now an important part of every large navy's forces.

dhow—A small sailing vessel common in Egyptian and Arabian waters. It generally carries one or two lateen sails.

dinghy—A small open boat used as a tender for a yacht.

dock—An artificially constructed basin for the reception of vessels. It may be a wet dock, where ships lie while loading and unloading, or a dry dock, in which they are repaired after the water is pumped out.

dock yard—An enclosed area in which the work connected with the building, fitting out, or repair of ships is carried on.

drabblor—An additional strip of canvas, sometimes laced to the

- bottom of the "bonnet" on a square sail when the wind is light.
Rarely seen nowadays, but common in the Middle Ages.
- draft**—The depth beneath the surface of the water of the lowest point of a ship's keel.
- dreadnaught**—A modern battleship carrying heavy armour and a main battery of guns all of a very large and uniform calibre.
- driver**—The fore-and-aft sail on the mizzenmast of a square-rigged ship. It is sometimes called the spanker.
- dry dock**—An artificial basin which can be flooded in order to permit the entry of ships, and then pumped dry in order that their hulls may be examined, painted, and repaired.
- dugout**—A canoe or boat made from a log hollowed out and cut down until it has become a vessel capable of carrying one or more passengers.
- ensign**—The flag carried by a ship as the insignia of her nationality.
Also, the lowest commissioned officer of the United States Navy.
- fathom**—A nautical measure, equal to six feet.
- fid**—A bolt of wood or metal which holds the heel of a topmast.
- fife rail**—A plank or rail in which a group of belaying pins is kept.
- figure of eight**—A knot. For illustration see page 193.
- flagship**—That ship of a fleet or squadron which flies the flag of the admiral in command.
- fore and aft**—An expression signifying those sails which, when at rest, lie in a line running from bow to stern of a vessel. The sails of a schooner are fore and aft.
- forecastle**—Formerly a raised "castle" built at the bows of ancient and mediæval ships from which the decks of enemy ships could be attacked. Nowadays the quarters of the crew on board ship—generally in the bows of ships.
- foremast**—The mast nearest the bow of a vessel having more than one mast, except on yawls, ketches, and other sailboats where the mast nearest the bow is larger than the mast farther astern.
- foresail**—On a square-rigged ship, the lowest square sail on the foremast. On a schooner, the sail stretched between the boom and the gaff on the foremast.

forward—The forward part or the forepart; that is, the vicinity of the bow of a vessel. To go *forward* is to go toward the bow.

freeboard—That portion of a vessel's side which is free of the water; that is, which is not submerged.

freighter—A ship engaged in carrying freight.

frigate—A warship of the last days of sail. It was full rigged and had two decks on which guns were mounted. The *Constitution* is a *frigate*. For illustration see page 145.

full-rigged ship—A ship carrying three masts, each mounting square sails. For illustration see page 201.

funnel—The smokestack or chimney connected with the boilers of a ship.

furl—To roll a sail and confine it to its yard or boom.

gaff—The spar at the top of some fore and aft sails, such as the mainsail or foresail of a schooner.

galleon—A heavy vessel of the time of Spain's nautical supremacy.

galley—(1) In ancient and mediæval times a ship of war propelled by oars and sails. (2) The kitchen of a ship.

gangplank—A movable runway used to bridge over the gap from a ship's deck to a pier.

gangway—A narrow platform or bridge passing over from one deck of a vessel to another, as from the poop to the midship deck of a freighter.

gear—Any part of the working apparatus of a vessel, as the gear of the helm, which consists of the tiller, the chains, the blocks, and all other necessary parts.

gig—A small boat formerly often carried on shipboard and meant for use when in port.

gimbals—The brass rings in which a compass is mounted, and which permit it to remain horizontal despite the motions of the ship.

gondola—A Venetian boat, used in the canals more or less as taxicabs are used in streets. It is propelled by one or two oarsmen, each with a single oar.

granny—A knot. For illustration, see page 193.

graving dock—Same as dry dock.

ground—To run a ship into water so shallow that she rests on the bottom.

ground tackle—The gear connected with and including the anchors of a ship.

gunboat—A small warship used for minor naval duties.

gunwale—The top of any solid rail along the outside of a vessel is generally called a *gunwale*.

guy—A steadying rope, as the *guy* of a spinnaker, which serves to keep that sail forward.

gybe—The swinging over of a fore and aft sail when the wind, accidentally or intentionally, has been brought from one side of it to the other around its free edge. This is sometimes a foolish and dangerous manœuvre.

halyard—A rope (sometimes a chain) by which a sail, flag, or yard is hoisted.

handsomely—A term which sounds contradictory. It means the opposite to hastily, and is used often with reference to ropes or halyards; as, "Lower away *handsomely*," which means lower away gradually.

hatchway—An opening in the deck of a vessel through which persons or cargo may descend or ascend.

hawsepipes—Short tubes through which the anchor cable passes from the forward deck to the outside of the bow.

hawser—A cable or heavy rope used for towing and for making fast to moorings.

head sails—All the sails set between the foremast and the bow and bowsprit of a sailing ship. These are the fore staysail and the inner, outer, and flying jibs. Occasionally there may be others, such as a spritsail.

helm—Used interchangeably with the word "tiller." Theoretically, every rudder is equipped with a helm or tiller, although actually tillers are seldom used except on small boats. To port your *helm* (tiller) means to push the handle of the tiller to the port side. This steers the vessel to starboard. Therefore, when the order to port the *helm* is given on board any ship, it is intended

that the steering apparatus be so operated that were there a tiller on the rudder it would be moved to port.

hermaphrodite brig—A two-masted sailing ship with square sails on the foremast and fore-and-aft sails only on the main. This type is often incorrectly called a brigantine. For illustration see page 201.

hold—The inner space in a vessel in which the cargo is stowed.

holystone—A soft, porous stone used for scouring the decks. Its name comes from its shape, which fancy has suggested is that of a Bible, and to the fact that when it is in use the sailors are invariably on their knees.

hull—The hull is the body of a vessel, exclusive of rigging or equipment.

Jacob's ladder—A collapsible ladder made of wooden steps strung between two ropes. It is used over the sides of a ship when the ship is at sea, as, for instance, when a pilot comes aboard or departs.

jaws—The horns at the end of a boom or gaff, which keep it in its position against the mast.

jib—One of the triangular headsails of a sailing vessel. There are several, as follows: balloon jib, flying jib, inner jib, jib of jibs (only on large ships), jib topsail, middle jib, spitfire, standing jib, storm jib.

jib-boom—A spar running out beyond the bowsprit for the purpose of carrying other jibs. *Flying jib-boom*—A boom extending beyond the *jib-boom* for the purpose of carrying the flying jib.

jigger—The fourth mast from the bow in a ship carrying four or more masts. The second from the bow in a yawl or a ketch.

jolly boat—A boat corresponding to a dinghy.

junk—A ship common in China and Japan. It is ungainly in shape, but is often remarkably seaworthy. It is driven by sails which are often made of matting.

kayak—A small canoe used by the Eskimos. It is made by covering a light framework with skins, and is decked. Generally

there is but one hatch just large enough for a single occupant to sit in. Occasionally there are two of these openings. It is propelled by paddles.

kedge—A small anchor carried by large vessels for use in shallow water or for use in keeping the main anchor clear.

keel—The backbone of a ship. It is a strong member extending the entire length of the centre of the bottom, and from it the ribs are built at right angles. *Fin-keel*—A thin and deep projection below the keel of some sailing ships, principally yachts, designed so as to prevent the ship from being blown sideways by the wind, and generally weighted at the bottom by an addition of lead or iron to insure stability to the vessel.

keelson—An addition to the keel inside the boat. It rests upon the keel and strengthens it.

ketch—A sailing vessel with two masts and with fore-and-aft sails. The mast nearer the bow is the larger of the two and is called the main. The one toward the stern is, in America, generally called the jigger, and in England the mizzen. It is placed just forward of the wheel or tiller. It is in this particular that it differs from a yawl.

knot—A nautical mile per hour is a measure of speed. It is often incorrectly used as a synonym for a nautical mile.

knot—The fastening of a rope. For illustrations see page 193.

landlubber—An uncomplimentary term used by sailors in reference to any one not familiar with ships and the sea.

larboard—The old term for port, or the left-hand side of a vessel. No longer in use because of its close resemblance to starboard, which is the term meaning the right-hand side.

lateen—A triangular sail of large size hung from a very long yard. It is common in Egyptian waters and is to be seen occasionally about the Mediterranean and in the East. The yard is often of immense length, sometimes being twice as long as the boat itself.

launch—A small vessel propelled by some kind of motor, and generally used for pleasure. To *launch*—To put a new vessel into the water. This is ordinarily a function of more or less formality.

- lead**—A leaden weight attached to the end of a line used to measure the depth of the water.
- lee**—The lee side of a vessel is the side opposite that against which the wind blows. A lee shore is a shore on the lee side of a ship, and is therefore to be feared, for the force of the wind tends to blow the ship ashore. "Under the *lee* of the shore," however, is an expression meaning in the shelter of a shore line from which the wind is blowing.
- leech** (meaning **lee edge**)—The aftermost, backmost, or lee margin of a sail.
- leg-of-mutton**—A triangular sail sometimes used on small sailboats.
- leeward**—On the lee side. An object to *leeward* is on the lee side. Pronounced "loo-ard" or "lew-ard."
- lifeboat**—A boat carried for the purpose of saving lives in case the ship which carried it is wrecked. Strict laws force all ships to carry these small boats, and the ships must carry life preservers in addition. Lifeboats are also maintained ashore in order to assist the crews of wrecked ships.
- lighter**—A barge intended for use in port or on rivers and meant to carry freight. The name comes from the fact that these barges "lighten" or unload ships. Ships also are often loaded from them.
- lighthouse**—A structure erected ashore or in shallow water and equipped with a powerful light, visible for miles at night. This acts as a warning, and shows the position of the danger to navigation which it is erected to mark.
- lightship**—A floating lighthouse, securely moored where it may mark a danger, such as a reef or a shoal, or at the entrance to a harbour in order to show the safe way in.
- line**—A small rope. *The line*—A nautical expression for the equator.
- line-of-battle ship**—The most powerful naval vessels at the end of the days of sailing navies.
- liner**—A term which has come to mean a large passenger ship operated by a steamship line. The expression seems to include only salt-water ships. For instance, a river steamer, even

though operated on a regular schedule by a steamship line, would not be called a liner.

log—An instrument that measures the distance a ship travels through the water. (2) The journal in which all the events of importance and interest on board ship are carefully written.

lubber—An awkward fellow.

lubber's line—A line marked on the inside of a mariner's compass case, showing the exact fore and aft direction of the ship. The moving compass card revolves so that the points or degrees with which it is marked pass close to this line, and thus the man who is steering the ship can always tell exactly the direction in which the ship is headed.

luff (of a sail)—The weather edge; that is, the edge toward the wind. To *luff*, in sailing, is to bring a vessel's bow more toward the wind.

lug—A type of sail of which there are three principal kinds: dipping lug, balance lug, and standing lug. A lug sail is four-sided and is hung from a yard which is mounted on a mast in a fore and aft position. See illustration of lugger, page 201.

lugger—A boat using a lug sail.

main—In all rigs of vessels the word "main" applies alike to the principal mast and the principal sail it carries. Generally in ships equipped with two or more masts the second from the bow is the mainmast, although in some rigs, such as ketches and yawls, the mast nearest the bow is the main.

marine—A man in the naval service serving something like a soldier on board a warship. Nowadays the duties of marines often take them ashore where their services are identical with those of soldiers.

mariner—Anciently a first-class or able-bodied seaman.

martingale—The rope extending downward from the jib-boom to the "dolphin striker." Its duties are those of a stay, or brace.

mast—A long piece or system of pieces of timber or metal placed nearly perpendicularly to the keel of a vessel to support rigging, wireless antennæ, halyards, etc.

master—The captain of a merchant vessel.

mate—literally the master's assistant. There may be as many as four or five mates on a ship, rated first, second, third, etc. They are officers next in rank to the master.

mess—At sea a company of men or officers who eat or live together.

'midships—The same as **AMIDSHIPS**.

mile—A nautical mile equals one sixtieth of a degree of latitude, and varies from 6,046 feet at the equator to 6,092 in latitude 60 degrees.

mizzen—Generally the third mast from the bow of a ship carrying three or more masts is called the mizzenmast. The sails set from this mast have the word "mizzen" prefixed to their names, as *mizzen* topsail, *mizzen* topgallant sail, etc. Also parts of the mast prefix the word, as *mizzen* topmast.

moonraker (or **moonsail**)—In square-rigged ships the sail set above the skysail. (Very rare.)

moor—To moor is to make a ship fast to a mooring which is a kind of permanent anchor to which a buoy is attached.

Mother Carey's chicken—A small seabird, properly called the stormy petrel (*Procellaria pelagica*).

nautical mile—See **MILE**.

naval architecture—The science of designing vessels.

navigation—The science which enables seamen to determine their positions at sea and to lay down courses to be followed.

nun buoy—A buoy which shows above water in the shape of a cone.

oakum—A substance to which old ropes are reduced when picked to pieces. It is used in calking the seams of boats and in stopping leaks.

oar—An instrument used in propelling boats by hand. It may be of any length over four or five feet, although, as it is meant to be operated by man power, it must be limited in size so as not to constitute too great a weight. It is made up of a handle, a shaft, and a flat section meant to come in contact with the water. At about one third of the distance from the handle to the end of the blade it rests in a special fitting called an oarlock

or a rowlock. By submerging the blade in the water and pulling the handle in a direction at right angles to the length of the oar, it tends to propel the boat. It differs from a paddle in that a paddle does not rest in a lock. A sweep is a very large oar, generally operated by several men.

oilskins—Waterproof coats and trousers worn over other clothing at sea.

on soundings—When a ship is in water shallow enough to permit the depth to be easily ascertained by means of the lead she is said to be *on soundings*. At sea the expression *to sound* means to learn the depth of the water by means of the lead.

outboard—Board means the side of a vessel; therefore *outboard* means outside her or beyond the gunwale.

outrigger—A type of small boat common in the East Indies is one made up of a narrow hull kept from overturning by a small timber floating in the water parallel to the hull and made fast to the hull by means of crossbars. This type is known as an *outrigger canoe*. The outrigger is the small float that keeps the canoe from capsizing. For illustration see page 17.

overboard—Over the side of a ship.

packet—A small passenger or mail boat.

paddle—A kind of oar. In use, however, a paddle uses no leverage except what is offered by the hands of the operator.

paddle-wheel—A large wheel sometimes used by steamboats and on which flat boards are so arranged that when the wheel turns the boards come in contact with the water, thus propelling the boat.

painter—A rope attached to the bow of an open boat, by which the boat may be tied.

peak—The upper end of a gaff. Also the uppermost corner of a sail carried by a gaff.

peak halyards—The halyards or ropes by which the peak is elevated.

pier—A long narrow structure of wood, steel, or masonry, built from the shore out into the water, and generally used for the transfer of passengers and goods to and from ships.

pilot—A man qualified and licensed to direct ships in or out of a harbour or channel. He boards the outgoing ship as she sails and is taken off, once the ship is outside the restricted waters that he is licensed to take her through, by a pilot boat. Incoming ships take pilots from the pilot boat as they approach the restricted waters where pilots are needed.

Plimsoll mark—A mark placed on the sides of ships by Lloyds or some other marine insurance firm, to show how deeply they may be laden. As a cargo comes aboard, a ship sinks in the water, but the insurance is void if the Plimsoll mark is sunk below the water line.

point—The card of a mariner's compass is generally divided into thirty-two parts. These are the points of the compass. Nowadays compasses are more and more being divided into degrees, but still the points are generally shown as well. *Reef points*—short ropes hanging in rows across sails to make it possible to tie a part of the sail into a restricted space so as to present less surface to the wind.

poop—Properly, an extra deck on the after part of a vessel.

port—The left-hand side of a vessel when one is facing the bow.

port tack—A sailing vessel is on the port tack when under way with the wind blowing against her port side.

porthole—An opening in the side of a vessel. The term generally refers to the round windows common on most ships.

prau—The Philippine name for a type of canoe. Praus may or may not have outriggers.

propeller—A heavy apparatus somewhat similar to an electric fan in appearance, which, when mounted on the end of a shaft outside the stern of a vessel, below the water line, and set to turning by the engines, moves the ship through the water.

proW—The cutwater of a ship

punt—A small flat-bottomed boat, generally square ended.

quarter—That section of a ship's side slightly forward of the stern. The port quarter is on the left side and the starboard quarter is on the right to the observer facing forward.

- quartermaster**—A petty officer on board ship, whose duties have to do almost exclusively with steering the ship and with other tasks about the bridge.
- quay**—An artificial landing place, generally of greater area than a pier.
- quinquireme**—An ancient ship propelled by five banks of oars.
- raft**—A group of any timbers bound together to form a float.
- ratlines**—Small lines crossing the shrouds of a ship and forming the steps of a ladder by means of which sailors may mount the masts. Pronounced "rat-lins."
- reef**—A low ridge of rock usually just below the surface of the water. (2) To *reef* a sail is to reduce the area spread to the wind by tying part of it into a restricted space.
- reef point**—See POINT.
- revenue cutter**—A ship operated by a government to prevent smuggling and otherwise to enforce the law.
- ribs**—The members which, with the keel, form the skeleton of a vessel.
- riding lights**—The lights a ship is required by law to carry at night while anchored.
- rig**—The manner in which the masts and sails of a vessel are fitted and arranged in connection with the hull.
- rigging**—The system of ropes on a vessel by which her masts and sails are held up and operated.
- roadstead**—A place of anchorage at a distance from the shore.
- row**—To propel a boat by means of oars is to row.
- royal**—In the built-up mast of a square-rigged ship the fourth section above the deck is the royalmast. Its complete name prefixes the name of the mast above which it rises, as *fore royal-mast*. The sail on the royalmast is named accordingly, as *fore royal*. The royal yard is the yard from which the royal sail is spread.
- rudder**—A flat, hinged apparatus hung at the stern of a ship, by the movement of which the ship is steered.
- running lights**—The lights that a ship is required by law to carry at night while under way.

sail—A sheet of canvas or other material which, when spread to the wind, makes possible the movement of a vessel. For various sails in use see illustration, page 213.

schooner—A fore-and-aft rigged vessel with two or more masts, the foremost of which is the foremast. See page 201.

scout cruiser—A very fast and lightly armoured modern warship smaller than a battle cruiser but larger than a destroyer, used for scouting.

scow—A large flat-bottomed boat without power and of many uses.

screw propeller—See PROPELLER.

scuppers—Openings in the bulwarks of a ship to carry off any water that may get on the deck.

seam—The space between two planks in the covering of a vessel. It is in the *seam* that the calking is placed.

seamanship—The art of handling ships.

sextant—The instrument in almost universal use at sea for measuring the altitude of the sun and other celestial bodies. From this the latitude and longitude may be worked out.

sheepshank—A knot. For illustration see page 193.

sheer—The straight or curved line that the deck line of a vessel makes when viewed from the side.

sheet—The rope attached to a sail so that it may be let out or hauled in as occasion may require.

ship—A term applied indiscriminately to any large vessel, but among seamen it means a sailing vessel with three masts on all of which square sails are set. For illustration see page 201.

shoal—A shallow place in the water.

shoot the sun—A bit of nautical slang, meaning to determine the altitude of the sun with a sextant.

shrouds—Strong ropes forming the lateral supports of a mast. Nowadays they are usually wire rope.

skiff—A small open boat. In different localities it is of different design. Occasionally fairly good-sized sailing vessels are called skiffs.

skipper—The master of a merchant vessel, called, by courtesy, captain ashore and always so at sea.

skysail—The square sail sometimes set above the royal. It

carries also the name of the mast on which it is set, as *main skysail*.

sloop—Sailing vessel with one mast, like a cutter but having a jib stay, which a cutter has not. A jib stay is a support leading from the mast to the end of the bowsprit on which a jib is set.

smack—The name given indiscriminately to any sort of fishing vessel using sails.

snow—A vessel formerly common. It differs slightly from a barque. It has two masts similar to the main and foremasts of a ship, and close behind the mainmast is a trysail mast. This vessel is about extinct.

sounding—Determining the depth of water and the kind of bottom with the lead and line.

southwester—(pronounced sou-wester)—A waterproof hat with the widest part of the brim at the back.

spanker—The fore-and-aft sail set on the mizzenmast of a square-rigged ship. Sometimes called the driver.

spar—A spar is any one of the timber members of a vessel's gear.

spinnaker—A racing sail of immense spread reaching from the topmast head to the end of a spinnaker boom which is a spar set out to take it. Sometimes it is possible for the same sail to be made to perform the services of a balloon jib, by carrying the spinnaker boom out until the end to which the sail is made fast is beside the end of the bowsprit.

splice—(Verb) To join rope by interweaving the strands. (Noun) The joint made in rope by interweaving the strands.

spritsail—A sail common before the introduction of the jib. It is a small square sail set on a yard hung below and at right angles to the bowsprit. Sometimes, formerly, a short vertical mast was erected at the end of the bowsprit, and from this was set the sprit topsail.

squadron—Part of a fleet of naval ships under a flag officer.

squall—A sudden and very strenuous gust of wind or a sudden increase in its force. Small storms that come up quickly are often called squalls.

square rigged—That method of disposing of sails in which they

hang across the ship and in which they are approximately rectangular in shape.

starboard—The right-hand side of a vessel to a person facing the bow.

stays—Supports made of hemp or wire rope supporting spars, or, more especially, masts.

staysails—Sails set on the stays between the masts of a ship or as headsails.

stem—The foremost timber of a vessel's hull.

stern—The rear end of a vessel.

stern castle—In ancient times an erection built at the stern of a ship to assist in its defense.

stevedore—A man whose task it is to stow the cargoes of ships and to unload cargoes.

stoke hold—That compartment in a steamship from which the fires under the boilers are stoked or tended.

stoker—A man who stokes or feeds the fires beneath the boilers of a ship.

stow—To stow a cargo is to pack it into a ship so that it will not shift as the vessel pitches and rolls.

studding sails—On square-rigged ships narrow supplementary sails are sometimes set on small booms at the sides of the principal square sails. These are studding sails.

submarine—A ship which is so designed as to be able to dive beneath the surface.

supercargo—A member of a ship's crew whose duties have only to do with superintending transactions relating to the vessel's cargo.

superdreadnaught—A battleship of considerably greater strength than the original British battleship *Dreadnaught*, which gave its name to a class of ships.

swamp—To be swamped is to have one's boat filled with water, but not necessarily to sink.

sweeps—Very large and clumsy oars, sometimes used on sailing ships to move them in calms, or in narrow places where it is impracticable to use their sails. They are also sometimes used on barges and rafts.

swell—An undulating motion of the water, always felt at sea after a gale.

tack—To tack in sailing is to change the course of a vessel from one direction or tack to another by bringing her head to the wind and letting the wind fill her sails on the other side, the object being to progress against the wind.

taffrail—The sternmost rail of a vessel, that is, the rail around the stern.

tarpaulin—A waterproofed canvas. Formerly it was waterproofed by the application of tar.

telltale—An inverted compass, generally mounted on the ceiling of the captain's cabin. Thus, without going on deck, or even without lifting his head from his pillow, the captain can check up the course the helmsman is steering.

tender—A small vessel employed to attend a larger one.

tholes or **thole pins**—Pegs fitted into holes in a boat's gunwale and between which oars are placed when rowing.

throat—That part of a gaff that is next to the mast, and the adjoining corner of the sail.

throat halyard—The rope that elevates the throat.

thwart—Athwart means across, and in a boat the seats are called the thwarts, because they are placed athwart or across the boat.

tiller—The handle or beam at the top of the shaft to which the rudder is attached, and by which the rudder is turned. It is in use only on comparatively small vessels.

tonnage—The measure of a ship's internal dimensions as the basis for a standard for dues, etc.

top—In square-rigged ships the platform built on the masts just below the topsails, and to which the sailors climb by means of the ratlines. The name of the mast on which the top is located is prefixed, as, *main top*, *mizzen top*, etc.

topmast—In a mast built up of two or more parts the topmast is the second from the deck.

topgallant mast—In a mast built up in sections the topgallant mast is the third section above the deck.

topsail—The second sail from the deck on any mast of a square-

rigged ship. Sometimes ships have lower and upper topsails, but in this case each of these is narrower than the ordinary topsail. The name of the mast on which the topsail is set is prefixed, as, *fore topsail*, *main topsail*, etc. On fore-and-aft rigged vessels the topsail is a triangular sail set between the gaff and the topmast.

topgallant sail—The third sail from the deck on any mast of a square-rigged ship, except when the ship is equipped with lower and upper topsails, in which case the topgallant sail is the fourth.

topsail schooner—A schooner which, on the foremast, spreads a square topsail.

torpedo boat—A small, fast ship of war built to use torpedoes as its major weapons. This type was common during and after the Spanish-American War, but became extinct, or practically so, after the introduction of the torpedo-boat destroyer.

torpedo-boat destroyer—See DESTROYER.

tramp—The name usually given to merchant freighters that have no regular routes. They carry almost any cargoes that offer, and may carry them to almost any port.

trawler—A vessel usually driven by power and used in fishing. It tows a heavy net called a trawl.

trick—At sea, the time allotted to a man to be at the wheel or on any other duty.

trireme—In ancient times, a ship propelled by three banks of oars.

trysails—Small sails used in bad weather when no others can be carried, or, occasionally, for rough work.

trysail mast—In old ships a mast for hoisting a trysail. (Seldom seen.)

tug—A small, powerful vessel usually propelled by steam and used to assist larger ships about protected waterways. Tugs are also used to tow barges or almost anything that can float. In the narrow waters of harbours and particularly in going alongside piers and quays, large ships need the assistance that these small vessels give them. There are also larger tugs for use in towing barges or other vessels at sea. These are known as seagoing tugs.

turret—An armoured turntable in which the larger guns of war-ships are mounted.

turret steamer—A steamer which, below the water line, is similar to other ships, but which above the water line has its sides turned abruptly in, so that its main deck is greatly narrower than its water-line beam. For illustration see page 131.

twin screw—A ship equipped with two propellers is said to be a *twin screw ship*.

umiak—An open boat used by the Eskimos and some Northern Indians. It is made up of a frame covered with skins. Its size varies, but an average size would probably be in the neighbourhood of twenty feet in length.

vessel—From the French *vaisseau*. A general term for all craft larger than a rowboat.

vinta—A Philippine name for one type of outrigger canoe.

waist—Actually that part of a vessel between the beam and the quarter. In old ships with sterns highly raised it was that portion forward of this raised section—that is, the section of the deck that was lower than the rest.

wake—The track a vessel leaves behind her on the surface of the water.

watch—To stand a watch on board ship is to be on duty for a given time, usually, but not always, for four hours.

water sail—A small sail sometimes set beneath the foot of a lower studding sail. Rare.

ways—An incline built for a working foundation on which to erect the hulls of ships. When the ship is ready to be floated, it is slid, generally stern first, from the ways into the water.

weather—As a nautical expression this term is applied to any object to windward of any given spot; hence, the *weather* side of a vessel is the side upon which the wind blows. A vessel is said to have *weathered* a gale when she has lived safely through it.

weigh—To lift the anchor from the bottom is to weigh anchor.

well—A depression sometimes built in the decks of yachts or sailboats which is not covered over by a deck. It is often called a cockpit, and is for the convenience and protection of passengers and crew. (2) An opening leading to the lowest part of the bilge, in which the depth of bilge water may be measured.

whaleback—A disappearing type of steamer once common on the American Great Lakes.

whaleboat—A boat that is sharp at both ends and is propelled by oars. This type was used by whalers, and is now common on ships of war, because of its seaworthiness, ease of handling, and sturdiness.

whaler—A ship used in the whaling industry.

wharf—A loading place for vessels.

wheel—When used in its nautical sense, this expression refers to the wheel by which a ship is steered.

wherry—In different localities wherries are of different sizes and designs. They are small boats, generally driven by oars.

windjammer—A slang expression for a person who prefers sails to engines.

windward—That side of a vessel or any other object upon which the wind is blowing is the windward side. An object which is to windward is in the direction from which the wind is blowing.

wind sail—A tube of canvas, with wings of canvas at the top so arranged as to direct fresh air below decks. It is a kind of temporary ventilator.

wing and wing—In a fore-and-aft vessel it is possible, when running directly before the wind, to haul the sails on one mast out to starboard and those of another mast out to port. This is said to be sailing *wing and wing*.

wreck—A wreck is the destruction of a ship. The ship herself or the remnants of her after the catastrophe.

wreckage—Goods or parts of a ship cast up by the sea after a shipwreck.

xebec (pronounced "zebec")—A small three-masted vessel, lateen rigged, and often with an overhanging bow. Common in the Mediterranean.

yacht—A pleasure boat. The term is indefinite in application, and generally means only the more elaborate pleasure craft owned by the wealthy.

yard—A spar suspended from a mast for the purpose of spreading a sail.

yaw—To yaw in a sailing vessel is to deviate from the true course. It is often the result of having an inexperienced man at the wheel.

yawl—A sailing vessel equipped with two masts, the main and the jigger. (In England the jigger is often called the mizzen.) The mainmast is the larger of the two and supports one or more jibs, a fore-and-aft mainsail, and sometimes a topsail. The jiggermast carries a small fore-and-aft sail, and the mast is set astern of the tiller or wheel. For illustration see page 201.

zenith—The point directly overhead



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